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AT

KAIGA

The Other India Press
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Dedicated to the affectionate memory of Prof.L.T. Sharma and Dr B.V. Krishnamurti, two of Karnataka's best known (and loved) ecologists. They fought the Kaiga nuclear project till their last breath.

Impact of the Kaiga Nuclear Power Plant on the Ecology of the Western Ghats

By Nagesh Hegde

Introduction

The hill chain of Western Ghats is a rich heritage developed through several years. These ghats harbour almost the entire forest wealth of states of Gujarat, Maharashtra, Goa, Karnataka, Tamil Nadu and Kerala. The orography of these ghats interacting with the cloud-laden winds of South-West monsoon leads to the highest level of rainfall for Peninsular India. Consequently almost all the major rivers of South India originate in the Western Ghats.

Over the millenia the tropical evergreen forest clothing the ghats has evolved a tremendous genetic diversity of living organisms, a unique storehouse of many plants and animal species occurring no-where else in the world. To cap it all, this very chain of ghats has a rich treasure of minerals too.

Unfortunately this veritable treasure-house of natural resources has been subjected to severe exploitation over the last few decades. A number of hydel projects, irrigation projects, mining ventures, forest based industries etc. have been relentlessly operating here with little regard to ecological balance, or sustainability of the resource base --all to cater alien beneficiaries.

The Western Ghats have already paid heavily for our mistakes. This kind of erroneous developmental policy has resulted in large scale liquidation of natural resources and the gains have failed to percolate down to our masses. These hilly areas, although richly endowed with forests, minerals and water resources, are at a serious disadvantage in deriving any benefits from modern industry. The few industries that have come to this region have proven a blight rather than a boon. They have depleted natural resources, polluted the environment and brought little benefit to the local populace. The fragile ecosystem has tended to collapse under the assaults of exploitative development.

It is no surprise then that the recent decision of the Department of Atomic Energy (DAE) to locate India's sixth nuclear power plant in this past vestige of the tropical evergreen forest has evoked serious concern among the ecologist. While it has become a global phenomenon to debate the hazards of nuclear energy whenever a new atomic reactor is proposed, the wisdom of the nuclear technocrats is questioned in choosing Kaiga as the appropriate site. The main apprehensions are that ---

1. It is for the first time that a nuclear plant is proposed to be erected in the middle of a tropical evergreen forest.

2. It is for the first time that a plant is being located in the vicinity of a potential uranium deposit thus making both ends of the fuel cycle meet at the same place.

3. It is also for the first time that such a major venture is being undertaken without carrying out a systematic environmental impact analysis.

4. It is again for the first time a plant is located within a short distance from a cluster of major on-going projects that are highly vulnerable from the security point of view.

Geography of the Plant Site

Kaiga is situated on the bank of river Kali in the North Kanara district of Karnataka. It is about 40 kms. inland from the Arabian Sea where Kali debouches from deep gorges carved out of the steep west bank of the Western Ghats. It is bound by steep hills on three sides with closed canopy forests nurtured by heavy seasonal precipitation. The average annual rainfall of the area exceeds 250 cm. The climate is humid. The total duration of the rainy season is about five months, from June to October.

A total area of 1,700 hectares of forests and cultivated paddy fields will be taken over for the first two units of the proposed nuclear power plant, each of 235 MW capacity. The area at present is sparsely populated and just about 1,000 local inhabitants spread over some six villages will have to be evacuated. The nearest town of the west coast is Karwar 40 Km. away. The nuclear plant will be located adjacent to the proposed Kadra dam which itself would produce 120 MW of hydroelectricity, and entail evacuation of another 2,000 people from some 12 villages.

Other projects in the vicinity

Kaiga is surrounded by a series of massive on-going projects, each one of them claiming priority over others. The entire Kali basin within a short radius of 25 kms. is undergoing severe transformation upstream due to giant hydel projects. It is being developed to yield a total of 1610 MW of electric power through a series of dams, reservoirs, tunnels, power houses, surge tanks, pressure shafts, pen stocks and pick-up dams. The most important of these projects, the Supa Dam Complex which is considered to be the 'heart of the Kalinadi Hydro-Electric project' is beset with geological problems. 'As every cubic meter is excavated, a new problem is thrown up and the engineers and geologists face the problem...[2] Total submergence including Supa town is of the order of 25,000 hectares (of which 80% is forest land) and the total population affected uprooted is about 20,000. Altogether 11 dams will be constructed within 25 kms. upstream from Kaiga.

Preparations are afoot to establish a naval base, near Karwar at an estimated cost of Rs. 2000 crores. It is supposed to occupy 23,000 hectares of land, thus evacuating some 30,000 people from their ancestral villages. No provision is made to rehabilitate these people (except giving cash compensations) and it is obvious that they seek settlement in whatever niche they could carve in the forest.

Exploratory drilling for uranium is going on in the adjacent river basin of Gangavati near Arebail about 25 km. away from kaiga. Exploration in a stretch of 400x9 km. in the forested hilly area is at present confined to borehole drilling at intervals of 100 to 200 M.

Mining for manganese and iron ore is going on at a brisk rate on the upper reaches of the forests area at Bisgod and other places. Exploration for copper ore too is continuing within 20 km. of Kaiga.

Environment,Ecology and Habitat

As said earlier, the steep slope of the Ghats is a fine example of the West Coast tropical evergreen forests. Giant trees with buttressed bases and trunks that are unbranched for over 30 ft. spread their crown high above the ground. These closed canopy forests form a verdant roof, tempering the effect of the rain and standing upto the fury of the wind from June to September. This rich, stratified forest ecosystem is also a fragile one. The opening of the canopy may result in the destruction of the storeyed structure. Ensuing heavy precipitation leads to increased runoff, pronounced erosion and heavy flash flooding.

While the wind ward side of the Ghats is covered by dense evergreen vegetation, the leeward side is clothed with deciduous forests. Both types have a rich biological diversity so typical of the tropical forests. Their hot, moist climate seems not only to encourage mutations but also to allow them to survive in the process of natural selection in different ecological niches.[3]

Such an interesting section of the biosphere naturally harbours a rich variety of wild life. Very close to kaiga on the hinterland is the Anshi wild life sanctuary in about 15 km. distance. Uncommon species of birds like long-billed vulture,

pygmy woodpecker, Jordon's imperial pigeon, Malbar Pied and Hornbill, white headed myna and some 150 other species decorate these forests. Among the terrestrial animals one can locate sloth bears, tigers, panthers, wild pigs, wild dogs, gaur, spotted deer, sambar, barking deer, otter, monitor lizards, python and many others.

The region around Kaiga is characterized by cultivation of agro-forestry that mimic the natural forest ecosystem in their pattern of organisation. The mountain terrain harbours a number of fertile valleys where plantation crops like arecanut, coconut, pepper, betelvine, coco and cardamom are grown. The agro-ecosystem thus has the tree layer, a shrub layer, climbers and herbs. People in the Ghat section reside in isolated small cluster of villages with little or nor civic facilities like communication, health service and education etc. In fact, there has hardly been any road link to kaiga prior to the arrival of nuclear scientists.

There are three very important characteristics of ethnic groups around Kaiga. One is a 'siddhi group' of Negroid origin. The other group of Halakki tribe on the coastal side. The third one is of a strong contingent of nomadic milkmen called 'goulis' who keep moving with their cattle in search of new pastures.

Environmental Impact

Controversy over the nuclear power has often been focused on the hazards of reactors at plant sites. But as mentioned earlier, the Kaiga complex includes both the front and the tail end of the fuel cycle, beginning from uranium mining and milling at Arebail; transportation of uranium concentrates through the fragile forest belt to Hyderabad and back to Kaiga; fissioning uranium in the reactor; waste reprocessing, waste storage at the plant site at Kaiga. Hence, it is logical that a discussion on the ecological consequences of this nuclear enterprise at Kaiga begin from uranium mining.

Mining

The deleterious effects of uranium mining has been well-documented in Australia, Canada, France, Greenland, the U.S.A and other countries. The International Commission on Radiological Protection (ICRP) has recommended safe dosage of radon gas that emanates from quarrying. However the exact nature of the impact of the uranium mining, milling and tailing deposits vary from place to place, depending upon the sensitivity of the environment. In a region of heavy rainfall and steep slope like the one around Arebail; the many streams, springs, herbs, creepers, trees are bound to accumulate large quantity of radioactive dust. Mine tailings containing radium and thorium-230 both with long half lives reach out into the soil and waterways. Radon gas from tailings of the ore decays into non-gaseous polonium which clings to dust particles, gets easily inhaled to cause radiation of lungs of both man and animals.[4] Meanwhile the solvent used for extracting uranium from its ore in treatment for plants also becomes radioactive. These liquids have to be contained in special lagoons which will inevitably reach out to contaminate the environment. Such a situation has already arisen at Jaduguda mines in Bihar, India where even at sites 10 Km. away from the uranium concentration plant, grass and milk samples show the presence of radium entering the aquatic system.[5] While the DAE assures the people that there is 'no instance of radiation hazard is reported from exposure to radon emanation'. The situation elsewhere in the world is alarming. In 1976 measurements taken on a tailings pile at the French mine at Monts D' Ambazac indicated radiation levels between 12 to 120 times the maximum permitted concentration. The French Atomic Energy commission (CAE) admits that radiation levels in the vicinity of the Brugeaud mine are likely to be six times greater than those, around the nuclear reactors.[6]

Viewed in this background, it may be interesting to note that the DAE has not made any measurements of radon emission at Arebail, despite having been engaged in exploratory activity for the past three years. The Regional Director in charge of exploration at Arebail says, 'The amount of radiation emanating from these rocks is far less compared to...the beach sands of Kerala. In view of this, safety measures of radon monitoring at Arebail is not at all necessary'.[7]

Such a casual attitude not only precludes all possibility of preliminary data collection on the natural background radiation but also indicates the shape of things to come. Studies conducted in areas of high background radiation in coastal Kerala have shown that incidents of Down's Syndrome and mental retardation there is four times higher than that in the

normal (control) population.[8] Its frequency is found to be higher than that in England, West Germany, Denmark, Australia and North East Scotland.

Biological effects

Although no systematic studies have been conducted on the radiation effects on the tropical biosphere, artificially induced gamma ray exposure on oak- pine forest in Canada has shown profound effect on the health of the plants.[9] Whether due to mining or nuclear plant operation, if radiation stress is of long duration, it is found that the ecological succession is permanently delayed. Forests nearer the source of ionizing radiation are destroyed. One well known and undisputed evidence that radiation can cause mutations in flowering plants has come from spiderworts plant. (*Tradescantia ohiensis*). The petals, stamen filaments and stamen hairs of the spiderwort flower so quickly changed their colour from yellow to pink due to mutations induced by radioactivity that the Japanese farmers use these flowers as biological dosimeters to gauge the presence of radiation.[10] Some radioactive materials like iodine-131 get concentrated into plant tissues with high concentration factor of 3.5 to 10 million. Because when the radioactive nuclei get attached to plants or animals, absorbed radiation dose especially of beta rays becomes very much higher. Once these primary producers accumulate radioactivity it is bound to enter into the bodies of higher organisms through food chain.

Impact During Construction of Nuclear Power Plant

The pristine forest area around Kaiga is already being trampled due to road construction, helipad preparation, exploratory drilling and general survey activities. Building of roads, power transmission lines, pipelines, workers colonies and townships will soon begin. More than 1500 hectares of dense forests will soon be buzzing with human activity. Some 5000 workers will make it their abode for at least 10 long years. These labourers and their dependents are bound to exploit the forest for their housing, fuel, hunting and fodder needs. Hunting for wild boars and other big game in the nearby Anshi wild-life sanctuary located just 15 Km. away will be a routine event. Large scale degradation of the forest becomes inevitable not only because of the influx of workers but also due to the resettlement of the outgoing refugees.

Impact of Nuclear Power Plant Operation

Gaseous Release: It is a well-known fact that the routine operation of the nuclear plants and their ancillaries lead to a slow, inexorable rise in the background radiation levels. Radioactive wastes are emitted to both the atmosphere and the aquatic ecosystem. Certain radionuclides such as Krypton-85 and tritium are released in their entirety from the nuclear plants. A typical heavy-water reactor of the type proposed to be erected at Kaiga will emit 50,000 curies of tritium per year. This radioactive hydrogen easily finds its way into the human tissue through water. The maximum allowable dose in human tissue is at present one thousandth of a curie.

History is replete with radioactive gas releases, both open and secret, that have caused havoc to the animal population close to the nuclear plant and also several kilometers downwind. Although these gases do not concentrate in the human body, they transform themselves into biologically damaging cesium, strontium and yittrium inside the body, causing far more serious damages to the respiratory organs than external radiation. Incidents of cancer and infant mortality are closely linked with the release of radioactivity from heavily emitting reactors at Dresden, Indian Point, Brookhaven and Shippingport etc., in the United States.[11] Near the Lingen reactor in West Germany, death rate from leukemia is reported to have risen seven times in the ten years after the plant became operational. Infant mortality is strongly associated with the levels of strontium-90 and cesium-137 in milk. Both these reactor-byproducts are found at especially higher levels in meat. Animals vary in their uptake of radioactivity - pigs being six times as vulnerable as cows.[12] Strontium-90 is a key element in radioactive fallout and low level radiation. It readily becomes concentrated in the cows' milk, as has amply proved by the Chernobyl disaster.

Hazards of all these radioactive products will be many fold more in Kaiga because of the peculiar geo-climatic nature of the region. Emissions from the reactor invariably rise upwards through the Kaiga valley and sweep along the mountain ridges of the Western Ghats to be deposited on the grasslands, meadows, plantations and forests during heavy precipitation. It will have pronounced effect on the nomadic milkmen and other tribal people.

Liquid Release: The coolant water taken from the Kadra reservoir will be let out into the downstream of Kali river and into the estuary, with enhanced thermal regime. As such the river water is rich in iron and copper pyrites and sulphates due to mining activities upstream and leaching of copper deposits in the vicinity of Kaiga. Coolant water creates thermal stratification in the estuary and would result in anaerobic conditions in the bottom, where mud-grubbing life forms like prawn fishes dwell. Bottom becomes acidic and reduces sulphates to hydrogen sulphide, H_2S. It becomes soluble in water and is toxic to aquatic organisms.[12A] Release of reactor affluence impregnated with tritium will further aggravate the threat to the life supporting environment in the estuary. Warm water with the inevitable radioactive elements will, in all probability make the Kali river a veritable biological desert. When the marine fauna eat large quantity of radioactive plankton, it is bound to end up at the top most link of the food chain, the man.

Noise, Waste, Heat and Other Effluents: Noise, is generated at the steam turbines, electrical generators and at the draft-cooling towers located near the nuclear power plants. Sound pressure levels for large (150 meters and above) hyperbolic towers alone have been variously estimated, a reasonable approximate being 500 dB at 800 meters from installations.[13]

Nuclear power plants produce water heat load 60-70 percent higher than fossil fuel plants. A typical 200 MW reactor produces waste heat at the condenser at the rate of 13×10^9 Btu/Hr.

The other common pollutants are : grease, degreasing detergents, H_2SO_4 (to control pH), silt depressing agents, corrosion inhibitors, demineralizers like Na_2SO_4 and H_2SO_4, sewage and sanitary wastes, gaseous wastes from auxillary boilers, diesel engines and incinerators.

Effect of all these viz. noise, heat and noxious gases on the flora and fauna of the natural ecosystem around the Kaiga Nuclear power plant is bound to be quite serious. Besides, movement of radioactive raw materials, fuel components and waste products through the forest will have deleterious impact on the fragile mountain ecosystem.

A Look Back at the Future

The greatest impact of all will be on the long-term future of the Western Ghats and the West Coast. There is no known technique to dismantle a dead reactor. Even if it becomes available in the future it will be so expensive that the future people will prefer to safeguard the reactor chain rather than dismantle each reactor. This means that for thousands of years these defunct reactors will have to be carefully against the elements, landslides, earthquakes, breaching of upstream dams etc. Wind, rain, air and ground water will have to be watched closely for contamination. Thus, future generations will have to commit themselves to this technology even if safe, cheap and clean energy sources become available.

Kaiga hence poses a moral and ethical question too. Do we have a right to impose such a Hobson's choice upon the future generation?

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Kaiga interview 1:

Mr. R S Hegde, an advocate from Karwar, is the Convenor of the Ecological Society, Karwar.

Q: What have you got against the Kaiga atomic reactor?

Hegde: I read the newspapers, the literature on radioactive poisons, and I recognize the dangers. In our area many people especially the poor live on shell-fish. Once the radioactive pollutants enter the river, they will first affect the shellfish and other marine life. The poor will be the first victims. At our meetings with the nuclear establishment held here, I approached Ramanna and others with my doubts, but I did not get a satisfactory response.

Q: Has it been established that the water used to cool the reactor contains radioactive elements?

Hegde: The waste water will come from the mouth of the plant. Ramanna says that it will not be affected, but what if there are leakages? Another major issue is the temperature difference between the water taken from the Kadra reservoir to cool the plant, and the warm water returned to the river: such temperature differences will affect marine life.

The vegetation will also be affected. That is why I am opposed to the project. It is to be situated in the middle of a valley. The ecosystem will be affected. We ordinary citizens will not be allowed to go and see what is happening once the barbed wire comes up. So we will not be able to check. If our milk or our shellfish get contaminated, who is to know? Who will ever tell us? Our lifestyles will also change. This will become a battlefield, since it will be termed a sensitive area.

KAIGA AND KARNATAKA

By L T Sharma

1. The region is Karnataka, sub region is Uttarakannada District; the places, Arebail for uranium exploration and mining and Kaiga for setting up the Atomic Energy plant. Kerala refused and Karnataka accepted the A E Unit with folded hands because of the worsening energy situation.

2. Of the six sites identified on the West Coast and the interior Karnatak, only two were visited by the expert Committee and finally the one at Kaiga was selected. Kaiga is 45 kms away from the coast on the upstream of Kali river and is situated amidst the slopes of the Western Ghats.

3. Its selection was justified by the Atomic Energy experts because "there will be water, rain or no rain, land and population few and far between." That there is no industrial load anywhere near the place to utilise the energy and 400 K.V. line has to be drawn all the way to Bangalore or to the Andhra border involving heavy transmission loss, is no concern for those authorities. That within 50 kilometers radius there will be all the 11 power houses of Kali Hydro Project, a Naval Base supposed to be the biggest in the country both along with this Atomic Unit is not of much significance to the authorities of the D.A.E., even though the people have come to feel a security risk in this location.

4. Finding of uranium at Arebail, leading to exploration and now preparatory to mining is another aspect of concern to the people because it is open cast mining on the private lands without any information regarding the precautions to be taken. For the D.A.E. Chief even near the pitheads Atomic Energy production is feasible enterprise in the not so distant future. So Arebail and Kaiga form a new basis in the Atomic Energy development during the 7th & 8th Plan.

5. What is the role of the people? The paternal attitude of the D.A.E. Authorities, the State Government and the M.L.A.s that this will contribute to the development of the area and that it is all safe and that all aspects of the hazards 'If any' are and will be taken care of did not and cannot satisfy the people.

6. The voluntary groups like the Society for Environmental Awareness and Parisara Sourakshana Samittee (SEA & PSS) became active in informing the people of the area with slides, lectures and leaflets. They were assisted in the task by the Bangalore based voluntary groups like Prakruti and Avinash and TNC, CFD - Karnataka and other voluntary organisations engaged in rural development.

7. The people have been made aware and they took the initiative in asking questions to the scientists of the A.E.C who failed to answer them. The voices of protest lead ultimately in organising opposition to both the projects. The Government on their part conveyed a joint meeting of the top personnel of A.E.C. like Dr. Raja Ramanna, Dr. Srinivasan etc. with official Ministers, M.L.A.s and protesters. All political parties in the State had accepted the project. The Chief Minister justified his efforts in getting an A E Unit because of energy crisis. The questions asked by the protesters regarding the siting, the industrial uses, economics, and precaution against hazards could not elicit any clear cut replies except that A.E. is the only energy of the future and there is no danger in future and all safety measures have been envisaged.

8. Protesters declared that they were not satisfied with the reply given and their next move was to organise a two day workshop on Energy and Development with alternative strategies at Vajralli near Kaiga. In that workshop the questions of Uranium mining as well as Atomic Energy were discussed in detail. Energy specialists and alternative development strategists from Indian Institute of Science, economists of the S.E.A., Radiation research workers from

Kerala, social workers organising opposition to the Kakrapar Atomic Energy Unit, Gujarat along with voluntary groups and media representatives participated. Opinion was unanimous that these projects have more hazards then convenience and they are not economical, the district or the region will not in any way benefit. Workshop also noted with surprise that A.E. authorities did not come forward to give proper information to the public. Veteran men of letters like Shri Shivram Karanth blessed this voluntary venture.

9. Three padyatras followed this workshop in the talukas of Yellapur and Karwar where these two projects were situated; there was a tremendous upsurge of enthusiasm in opposing the project. At the initiative of Shri Karanth, the T.N.C. as well as the State Unit of the CFD took up the question of seeking a redressal in the Supreme Court. A Public interest litigation is being envisaged.

10. After Chernobyl, the D.A.E. has not given any public statement to the people of the area; everything is moving in a low profile even though they are bent upon continuing with them. The situation of Kaiga, in the Western Ghats and that near the place of mining at Arebail has to be properly understood by all concerned including the D.A.E. So far as our information goes no Atomic Plant is located in tropical forests and also near the pitheads.

11. The people are nowhere in the picture. The A.E.C. is producing power for industries. The industrial enterprise in this country is given the share in manufacturing the machinery for the Atomic Unit. They supply to the national grid. They also extract plutonium for their Breeder Plant at Kalpakkam. The energy crisis in the region and the country cannot be solved by the A.E. (even according to their own estimates it will be after the second half of the next century) because of the halting performances of the A.E. Units so far; at the most it may supplement other sources of industrial power and nothing more. Thus it is costly if you take into consideration the entire fuel cycle, hazardous as the world has already shown, polity oriented and has nothing to do with the people who are only to accept and not question this high technology given to them.

Kaiga interview 2:

G V Gaonkar, is Mandal Pradhan of Vajralli Mandal, and Member, Kali II Stage, rehabilitation project. Also member of the Janata Party.

Q: Your own party Chief Minister and MLAs are supporting the Kaiga plant.

Gaonkar: Our people are committed to oppose the reactors, even though our leaders are not with us. So to make the leaders aware of our feelings, we decided to express them in terms of a gherao, so that these feelings can be voiced also in the Legislative Assembly.

Soon after we gheraoed our MLA Deshpande, he met the Chief Minister, and the Chief Minister called on anti-nuclear activists on February 5, and promised a national debate this April or May.

Q: What is the point of a national debate, if the work at Kaiga has already commenced?

Gaonkar: Since the work has started, we have decided to meet the Chief Minister again and if the meeting does not materialize, we shall meet shortly to decide on what course of action we take in the near future.

THE KAIGA STORY

By Praful Bidwai

After battling it for months, the department of environment (DOEn) of the government of India has finally genuflected before the department of atomic energy (DAE) and cleared the controversial Kaiga nuclear power project in north Karnataka. The decision to grant approval to the 2 X 235 megawatt station was taken, as most such decisions tend to be taken nowadays, at 'the highest political level'. The manner in which it was reached is itself illustrative both of the way the DAE functions and of the nature of the process of nuclear decision-making in the country.

In the first place, what is remarkable about the Kaiga episode is that the DOEn should have raised an objection to the DAE's proposal early last year. Such a thing was of course wholly unprecedented: the powerful nuclear establishment of the country had until then never had occasion to be questioned by another department of the government. But, secondly, it is equally noteworthy that the DOEn's objection was not based on a questioning of the safety of the DAE's nuclear reactors, nor on the potentially adverse impact on the environment of accidental releases of radioactivity from the proposed station. Rather it was focused more narrowly on two issues. The first related to a dispute over the interpretation of an earlier clearance granted by the DOEn to the two proposed reactors as distinct from the project as a whole, which includes besides reactors, several auxiliary facilities and an entire new township complete with a housing colony, schools, markets, banks and provided with approach roads and a civic infrastructure. The DAE interpreted the clearance for reactors as being synonymous with approval for the project as a whole, although there is a substantial difference between the two. The DOEn disagreed.

The second component of the DOEn's objection pertained to one aspect of the immediate impact of the project on the local environment, in particular the destruction of a tropical rainforest in the Kaiga valley of Uttara Karnataka that the construction of the housing colony would involve. The DAE wanted to site the colony, occupying over 400 acres of land, on top of a hill about 30 kms away from the plant, rather than at Mallapur village adjacent to it. Interestingly, several of DAE engineers were themselves opposed to the location insisted on by the DAE Secretary, Raja Ramanna, as that would involve an hour's drive along hilly slopes and bends to reach the plant proper from the colony. They argued that locating the housing complex so far away could make no sense in simple operational terms, especially in case of an emergency at the plant.

But even more interestingly, Ramanna urged that the 'prestigious' project demanded an equally special, indeed unique site for the colony, even if that meant the wanton destruction of hundreds of thousands of trees, cutting up a lush-green hill and exposing a reserved virgin forest to encroachment by contractors. With its degraded forest, Mallapur, he said, was like 'a slum'; he owed it to the DAE staff to ensure that they don't have to live in a slum. Hence, they must be given the best, the most spectacular, location with a panoramic view of the entire Kaiga valley. They deserved a new hill station. Besides, siting the housing colony on the hilltop would obviate the need for airconditioners. And in any case, the DAE would plant many trees and beautify the area; had it not done so on the pretty campus of the BARC at Trombay?

The DOEn, for its part, conceded that the potential benefit from the project to a certain extent justifies its environmental cost in the form of destruction of the rainforest; but it argued that the destruction ought to be limited by siting the housing colony at Mallapur. It also maintained that the clearance granted earlier to the two reactors was not tantamount to approval for the colony and approach roads as well; and it pointed out that the DAE had not even bothered to submit a complete proposal before announcing that it was going ahead with the project, starting, inevitably, with the housing colony. In its Performance Budget for 1986-87, the DAE had already announced commencement of work on Kaiga and allotted funds without waiting for the DOEn's clearance.

As the battle raged on, the prime minister himself told the Lok Sabha on November 12 that the centre had not till then taken a decision on the location of an atomic plant in Karnataka. "We will definitely consider the location of the plant

on the merits of the case". He also said that India "has one of the best safety records in atomic energy", "but there is one area where we have a weakness and that is our capacity to cope with the situation in case of an accident".

But exactly four days later, the DAE 'clarified' that the Lok Sabha report by a news agency (PTI) was incorrect and that "the Centre" (whatever that may mean) had already announced "its decision to set up a nuclear power station... at Kaiga in Karnataka".

Meanwhile, pressure mounted on the DAE to give up the hill station plan and agree to locate the housing colony at Mallapur. It agreed to do so at the intervention of the prime minister's secretariat. The DOEn in turn dropped its objections and cleared the project. The trade-off, however lop-sided it might have been, was completed.

The whole episode not only highlights the arrogant posture of the DAE - a characteristic of the department which has always resisted scrutiny by any other agency. It also exposes the sloppy nature of the system of environmental impact assessment that is prevalent even in respect of projects based on hazardous technologies. Kaiga is indeed a prime example of a project that should never have been cleared on environmental grounds.

There are several persuasive reasons why the project proposal should have been rejected outright. First, the Kaiga valley probably has the last vestiges of a tropical rainforest left in one of the more vulnerable parts of the Western Ghats, themselves among the most gravely threatened ecosystems of the country. It is impossible to regenerate a virgin rainforest: a forest is not just a plantation. There is thus a strong case for leaving undisturbed a delicate and precariously balanced rainforest-based ecosystem by disallowing all industrial or mining activity in the area.

Secondly, the project is located within a 50 kms distance from no fewer than six reservoirs on the Kali river; it will itself draw water (for final removal of the heat generated in the reactor) from the proposed Kadra dam to be located next to it. If past experience with reservoirs in the Deccan Plateau region--in particular, with the Koyna and Panshet dams and the disasters that befell them--is any guide, the Kaiga site must be considered problematic from the geological point of view.

Thirdly, the site falls within seismic zone III, close to its boundary with zone II, according to the revised Seismic Zoning Map of India (15: 1893: 1975). A primary deep-seated northwest-southeast fault, reflected in the ONGC's Tectonic Map of India, which runs from near the Cauvery basin upto Ratnagiri, lies just about 70 kms northeast of Kaiga. There is another northeast-southwest trending fault passing through the Tungabhadra river and close to Raichur; this is also within 70 kms of the site. And yet another northeast-southwest trending fault, postulated by the Geological Survey of India, which runs upto the Tungabhadra dam and curves down towards Nagarjunasagar is only 60 kms southeast of Kaiga.

In addition, there are four other faults which lie within 25 kms to 115 kms of the Kaiga plant site. A UNESCO expert, Gubin, who studied the Koyna event, suggests another Western Ghats fault, from Panvel in Maharashtra to Calicut in Kerala, emerging from beneath the Deccan traps near Sawantwadi, just 25 kms east of the site. It is postulated that the Koyna fault which lies 225 kms northwest of Kaiga is an extension of the Western Ghats fault. Besides there are several clusters of earthquake epicentres close to Kaiga with magnitude going upto 5 on the Richter scale.

Fourthly, as if this were not bad enough, the Kaiga site is less than 30 kms, as the crow flies, from the massive naval base coming up at Karwar. Thus, the plant is potentially an important military target in the event of war. It needs no deep analysis to predict what the dropping of a few small conventional bombs on the Kaiga reactors would achieve: it would precipitate a disaster much worse than the Chernobyl catastrophe, poisoning vast stretches of land and contaminating the air, water and the food chain with dangerous radionuclides for decades.

And finally, even if the problems posed by the destruction of Kaiga's tropical rainforests and by the displacement of thousands of people from near the site were somehow to be solved, or rather, to be ignored, the basic question of nuclear safety would still remain. There are three components to this: the generic problems of nuclear reactor safety; the specific features of the CANDU design which themselves pose the possibility of a Chernobyl-type accident; and the DAE's own record in matters of nuclear safety.

Along with 150 serious nuclear accidents all over the world, Three Mile Island and Chernobyl have shown that no reactor design anywhere in the world is acceptably or reasonably safe. It has also become clear that the prevalent designs have all matured, i.e, reached the limits of their potentialities and cannot be improved significantly any further for safety.

The CANDU design - based on natural uranium as fuel and heavy water as moderator and coolant - which the DAE has borrowed from Canada, has some distressing features, most importantly, a "positive void coefficient of reactivity" (a characteristic that ensures that a power surge in the reactor leads to the formation of more bubbles in the coolant which in turn only reinforces the surge and precipitates a runaway nuclear reaction leading to a potential fuel meltdown). This feature the CANDU reactor shares with the Chernobyl-type design.

And as for the DAE's own appalling safety record - documented in "The State of India's Environment: The Second Citizens' Report" of the Centre for Science and Environment and elsewhere - the less said the better barring that it inspires no confidence whatsoever. Just the contrary; it would be perfectly reasonable for the people living close by to apprehend that the Kaiga station will jeopardise their safety and well-being, by exposing them to `routine'- but by no means harmless - releases of radioactivity into the air and water, poisoning the land, vegetation, water and animals and, most of all by presenting to them the permanent threat of a catastrophic accident that could spell the death of tens of thousands.

Such threats become all the more menacing because, as Rajiv Gandhi has himself confessed in a lucid moment, there is simply no plan for evacuation and because of the "weakness" of "our capacity to cope with the situation in case of an accident". It hardly needs to be added that in a thickly populated and primarily agricultural or biomass-based country, the human and environmental consequences of a nuclear accident will be incomparably worse than in Europe.

It is precisely on account of such considerations that a popular movement to resist the Kaiga project has now arisen in Karnataka. At least three organisations have emerged in the state which have been campaigning against the Kaiga project. Besides criticising the proposal on grounds of safety and lack of manageability, they have also persuasively shown that the project has little relevance for Karnataka's energy needs; indeed that it is not even necessary. These groups appear to have struck roots among the local population: no fewer than 1,00,000 people have signed a petition against the Kaiga station.

One would have hoped that the government, in particular the DOEn, might at least in token recognition of and in the wake of the Chernobyl catastrophe take their arguments into consideration before clearing the project. Certainly, with such a strong case against it, Kaiga at least deserved a wide public debate, if not a sustained public hearing on the question of nuclear safety and the location of atomic power stations. But that was not to be. Clearly, the DAE has once again had its way, this time at the expense of the people of Karnataka and at the cost of the safety of the millions who live in the Deccan or close to it.

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SHOWDOWN OVER KAIGA

By Claude Alvares

Introduction

A couple of decades from now, people will moan the singular idiocy of the men who planned and located a polluting atomic power complex in the midst of an untouched, evergreen canopied rainforest. The atomic power plants being erected at Kaiga, in a secluded nook of the Western Ghats, 55 kms from the port town of Karwar, North Kanara district, Karnataka, hold in them a known potential for environmental havoc that this ecologically bludgeoned and beleaguered civilization should do anything to avoid. But the men in control are men raised in an atmosphere of arrogance and extreme tyranny, contemptuous of democratic principle, and venal, as venal as the most despised of our politicians. They are not used to opposition of any kind.

And yet, there is a possibility that the Kaiga reactor complex may never really come up.

For at the site, and in the neighbouring villages, over the past three years, India's most powerful anti-nuclear agitation has been gathering strength for a showdown, causing considerable consternation among the country's nuclear barons. The agitators refuse to be assured that the nuclear industry will not inflict another Chernobyl kind of disaster on them and their environments, particularly on the rainforest on which their survival depends.

It is the people of this very district that in the early eighties fought successfully to have the Bedthi dam cancelled.

The nuclear lobby is clearly terrified of the agitation, and what it portends for the future of nuclear energy in India. For the first time it has tactically dropped its routine intolerance of any opposition to its plans, and, in order to sell its toxic product, even condescended to debate and argue with the agitators.

The agitation has charged the atmosphere in Karnataka and forced the state to appeal to the Centre to hold a national debate over nuclear energy this month.

Will the anti-Kaiga agitation succeed? ***Claude Alvares*** *who made numerous trips to the site, reports on the agitation, and concludes that in Kaiga the Indian nuclear estate seems to have finally met its match.*

The road to the village of Kaiga from the port town of Karwar along the country's west coast maintains a close distance with the Kali river, as if for comfort. Though recently constructed, its fate is closely tied to the fate of the river. The Kali will be dammed at Mallapur to form a huge reservoir to provide water for the cooling towers of the proposed Kaiga atomic plants. The road will be submerged under the impounded waters of what will be known as the Kadra reservoir.

At Mallapur, the Nuclear Power Corporation, India's latest public sector undertaking, has already optimistically begun putting up the workers and staffers colony for those going to erect the twin 235MW reactors at the site. Everywhere trees have been felled, logs litter the landscape, a portend of things to come in already treesless India. Contractors are removing the trees from the forest as thieves would remove gold fillings from corpses.

The houses in the colony are coming up on rice fields. Those working the paddy fields were given some compensation for the standing crop, and told to quit.

The village of Kaiga is off the tar road, which a short while later, turns into a mud track, winding its way immediately through the ghat, and the awe-inspiring tropical rainforest on it. A small wooden board nailed to a tree as another dirt track leaves the tar road announces: "Way to Kaiga site".

A brief kilometre away we enter a forest, meet another small wooden signboard mounted on a pole. It says simply Kaiga. A mischievous villager had added a "ji" to the word, so that it now read, "Kaigaji".

The board indicated the direction of the village, not the nuclear reactors whose proposed existence has already made this location world famous. The reactors have their own special signposts: multi-coloured GI pipes have sprouted everywhere among the trees, marking areas where geological surveys have been recently carried out. Some 500 metres to the left of the mud track more quarters are coming up.

Everywhere, trees lie felled in large numbers. This is the familiar pattern repeated: wherever development comes up, trees go down. Somehow, those who rule seem unable to understand any other language or pattern of behaviour.

There was no road to the village of Kaiga till 1985: the villagers had to traverse the 15 km length from Mallapur on foot. The siting of the reactors has brought the road to the village, but the village has now been told to quit. A thousand people from a number of settlements have been served notices under the Land Acquisition Act. The Government has followed these up with copies of caveats it has filed in the court, preventing the villages from getting any ex-parte stays. Who says an old dog can't learn new tricks?

The exact site where the reactors will come up, if they ever do, is designated in the records as a "minor forest". There are a few rice fields, and natural water concourses. Within a kilometre up the road into the ghat, the minor forest gradually thickens, raises a canopy, and diffuses the sunlight, in places blacking it out completely, so that even in the afternoon, one feels one is already approaching twilight. Trees rise to a height of more than 60 feet. Underneath, the dense growth prevents human access.

This forest was declared protected in 1862. It survived British colonialism. It is now destined to fall a victim to the opium dreams of nuclear power. This forest protected living beings for centuries just by being there, without the intervention of man. In a few years it will disappear, and in its place, modern India will erect atomic reactors which will generate electricity for about 25 years in fits and starts, while simultaneously generating radioactive pollutants that will remain to create their own brand of havoc for hundreds of years.

Ecologists have still only a dim idea of the true ecosystem value of a virgin rainforest. The complete extinction of these almost primeval communities of trees is seen universally as almost disastrous for mankind and especially for future generations.

In no part of the world has any reactor been located within a tropical rainforest. The rainforest will not be felled directly to make way for the reactors. That sacrifice is being reserved for the excellent "minor forest" below. But the plant squats well within the rainforest's embrace.

On April 16, 1988, while passing through the rainforest, I saw a fire raging over a couple of square kilometres in the area: it had been started by a contract labourer working on the road connecting Malavali in the ghats with Kaiga in the valley.

But in addition to these "accidents" which have now begun to occur and can only increase, it is now being accepted that the slow releases of radioactivity from reactors can harm vegetation downwind. One statistically based study done on forests and reactors in West Germany has indicated that such radioactivity might have played a greater role in the destruction of trees there than acid rain.

Thus, locating a reactor within the rainforest is very much like asking Mother Earth to sleep with a nuclear hazard ticking away in her arms and not expect her to get nightmares, turn grey and wither away.

We have stringent laws to protect our environment against such obscenities. The Forest Conservation Act (1980) withdrew powers to fell forests from the state governments and transferred them to the Centre. Henceforth, all development or other projects that involve the felling of forests must get prior clearance from the Ministry of the Environment and Forests at the Centre.

However, it is too much to think that the DOEF could have raised any worthwhile objections to any plans of the Department of Atomic Energy (DAE).

The DAE has shown in the past that it operates its projects independent even of the Central Cabinet. One good example of this became available on November 12, 1986, when the Prime Minister, Mr. Rajiv Gandhi, informed Parliament that the decision on Kaiga had not yet been taken by his Government. "We will definitely consider the location of the plant on the merits of the case", he said. Four days later, the DAE officially corrected him, saying that Kaiga had already been given the go-ahead. The Prime Minister, who is used to ticking off his foreign secretaries in public, kept his silence.

Tragic Development

Development has indeed been tragic for the people of North Kanara, a settled population living in symbiosis with the forests. Development in fact has underdeveloped this rich bioregion and its thriving economy. The overt excuse to do this has been "progress", the progress of people far away from these districts.

Each development project in Uttara Kannada has been massive in its impact on the fragile forest environment. More than 10 major projects have come up within a 50 km radius. The most impactful of these is the Supa Dam complex, the heart of the Kalinadi hydro-electric project. This dam alone destroyed 25,000 hectares of forest, and uprooted 20,000 people.

Within the region, off Karwar, comes Seabird, India's largest naval base, destined to uproot 30,000 people, including fishermen.

In Arebail, 25 kms from Kaiga, the Government is prospecting for uranium to feed its nuclear energy programme. Uranium mining is an environmentally polluting activity, and the prospecting is being carried out within another extensive patch of tropical forest.

For the forests, the settled villagers, the tribals, development has proved a curse. It seems to be taken for granted by planners that the rights and needs of the local villagers can be sacrificed for the interests of "power" and "industry". What about the development of the local people themselves? That is a question no one has asked, and planners pretend they have not heard it at all.

With the reactors at Kaiga, "development" now seeks to introduce dangers of a qualitatively different kind for this already traumatized district with which no human beings elsewhere have been able to cope without undergoing considerable stress and anxiety.

In the past, and except for the Bedthi dam, people in the district took such "development" lying down. But Kaiga for some reason ignited all the latent resentment accumulated over the past decade of intensifying misery. All that was needed was a small spark. It came in the form of a magazine article.

In Karnataka, the press exercises an influence directly on people's minds that it is difficult to conceive elsewhere. A few years ago, for instance, distinguished ecologist, B V Krishnamurti published an article in which he connected the drying up of water supplies in some villages to the wholesale planting of eucalyptus. Within days, villagers invaded Government forest nurseries, and uprooted millions of eucalyptus saplings.

The anti-Kaiga agitation owes much in its origins to a well-argued essay on the demerits and hazards of nuclear plants published in Sudha magazine, written by Nagesh Hegde of the Deccan Herald group. Most people remember the article and its arguments. A number of environment groups in Karnataka took up the agitation from there. These included Citizens Against Nuclear Energy (CANE), the Society for Environmental Awareness, Sirsi, Appiko, Manurakshana Koota, the Snehakunja at Kasargod, the Parisara Saurakshana Samiti, Yellapur, the Pragatipara Vidhyarthi Kendra, and the Society for Ecological Awareness at Karwar, a formidable coalition of environmental groups.

Some of these groups and individuals have had considerable experience organising public protest against regressive environmentally degrading development projects that often end up terrorising innocent villagers and assaulting the quality of life within the rural environment.

Thus, one of the most outstanding of these is a retired principal and historian from Sirsi, Prof. L T Sharma. Prof. Sharma was one of those deeply involved in the planning and execution of the anti-Bedthi dam seminar which ultimately led to the scrapping of the project. That was the very first collaborative effort between activists and intellectuals which led to successful intervention in such development politics.

The success of the anti-Bedthi agitation cemented the foundations for sustained environmental work in the state. A purely agitational form arose in the form of the Appiko movement, to save the forests from destruction by the forest department of Karnataka. On the other hand, groups like the Society for Environmental Awareness concentrated on educational work. But all came to unite against the Kaiga reactors. For their campaign, they were able to rely gratefully on the vast materials generated by a world-wide anti nuclear reactor movement, whose arguments against nuclear energy have reached such a level of sophistication and conviction that the nuclear lobby just ignores them altogether.

Of course, one must hand it to the intelligence of the nuclear barons that they immediately saw the possible consequences of the new combinations in the case of the Kaiga plant, and moved quickly to neutralize them. For this task, the top brass for the first time in DAE's history, decided to change tactics and to adopt a posture of reasonableness and even make efforts to meet the public in order to reassure them about nuclear safety.

The strategy failed. It might have worked elsewhere if the agitation had been limited only to the educated middle class and the intellectuals. Members of the latter, often confronted with technical jargon, are easily convinced, especially if exposed to complicated graphs and equations. In lectures given by nuclear experts, the tendency is to appear intelligent enough to understand what the engineer is talking about.

Villagers however are more conservative and much more adept at discovering whether someone is lying or has credibility. "They came here and showed us some drawings, and said this is how they will make electricity", a Kaiga villager said to me when I asked him if he knew what exactly was coming up in the area. "But", he added, "we don't understand a thing. All that we know is that it is dangerous for us and our future generations. And for that we are ready to agitate."

The popular agitation in the district actually commenced with a march against the plant by two young men from Sirsi to Karwar, three months after the Hegde article appeared. By August - September 1985, environment groups had organised a number of public meetings educating people about the proposed plant.

As the agitation picked up steam, reflected in the media, top officials of BARC and the DAE flew into Karwar and attempted a meeting with the villagers at Malavalli up in the ghats. Representing the nuclear establishment were T Subbaratnam and Mr. N S Sunder Rajan. The experts failed to reassure the villagers, 5000 of whom had gathered for the discussion. In addition to the scientists, R V Deshpande, the Minister for Small Scale Industry was also present, and coordinated the meeting. Also present was P S Rane, the Cong (I) MLA.

At this stage, the Chief Minister, Ramakrishna Hegde, himself took the initiative for another meeting in Bangalore, this time attended by Raja Ramanna, Mr. M R Srinivasan and others. At the meeting, which took place October 25, Hegde

promised to send teams of people to visit the different nuclear reactors in the country, so that fears could be allayed. The meeting was partly successful for the establishment: a good number of people attending felt they had been convinced that nuclear power was a safe proposition.

Recalls Subrahmanya Hegde, an activist, of the meeting: "It was decidedly a set-back for us. But we took immediate action, and convened a fresh meeting of activists on December 16, 1985, at the APMC Hall in Yellapur."

The crucial event in the anti-Kaiga agitation was an innocuously titled seminar on "Energy and Development", organised at the village of Vajralli, up in the ghats from February 1-3, 1986. The thrust of this workshop, organised and sponsored by the villagers themselves, was to understand the dangers of nuclear plants, discuss alternatives, and analyse the possible implications of the reactors, if built, on the ecosystem. The DAE was invited, but did not attend. It sent the meeting a speech by Raja Ramanna. The seminar was sponsored by the local villagers themselves.

It was at this meeting that activists and concerned scientists patiently explained all the major problems associated with nuclear plants: the question of radioactive waste, the problem of decommissioning old reactors, the consequences of nuclear accidents, the radioactive hazards of reactors during normal operations.

Momentum remained high against the nuclear reactors thereafter. March 7, activists commenced a padayatra from Sirsi via Kaiga to Karwar, a distance of 300 kms, for a duration of ten days. Though the core marchers were just 25, in places more than 500 villagers joined. "At a conservative estimate, we met about 20,000 people during that padayatra", said Subrahmanya Hegde, one of the principle activists from Yellapur.

The padayatra ended with a public meeting in Karwar, which was addressed by Shivram Karanth. A memorandum was then submitted to the District Commissioner, Karwar.

And then, from an entirely unexpected quarter, the movement got a major shot in the arm.

At the meeting convened by Ramakrishna Hegde on October 25, Ramanna had ridiculed a question from the audience that a nuclear reactor could explode. The *Deccan Herald* had reported him thus:

"The argument that was being given is that a reactor can explode like a bomb, which is physically impossible. Modern technology has built in so many safety devices that such a thing is not possible physically. When a reactor heats up, there is a negative temperature coefficient and the reactions become weaker. So heating makes it even more safe."

Ramanna told the audience that to expect a nuclear reactor to explode was like saying that if somebody jumped out of the window of a multi-storeyed building, he would fall "upwards" instead of downwards. These were mere old folk tales.

On April 26, 1986, hardly six months after Ramanna's statement on the physical impossibility of exploding reactors, unit 4 of Chernobyl exploded in the Soviet Union. Its after-effects included the radioactive contamination of Europe. In India, the explosion bored a neat hole in the credibility of the country's leading nuclear expert. It renewed the storm over Kaiga.

And those who had left the movement now returned to the fold.

In September, 86, Ramakrishna Hegde in a TV programme quizzed about the Kaiga plant, astounded his listeners by claiming that teams of critics had been to the other reactors as promised, and had given in their reports.

On October 25th, exactly one year after he had made the initial promise, Hegde himself was gheraoed at Sounda. About 500 people were present. The CM promised a national debate and confessed he had been given wrong information regarding the teams to the nuclear reactors. He reiterated his promise to send out the teams.

By April 1987, the activists had begun to organize workshops at Arebail, where uranium mining may one day take place.

On April 8, 1987, more than a hundred global experts, gathered together at the world conference on "Global Development and the Environment Crisis" at Malaysia, including Dr. Rosalie Bertell (winner of the Alternative Nobel), Nicholas Hildyard of The Ecologist, and others, signed a collective appeal to the Prime Minister stating "the (Kaiga) project has been pushed through without paying adequate attention to its environmental consequences." It also added: "Nuclear plants in the place of evergreen plants are contributing to the obliteration of our life-supporting system."

In November the same year, a number of anti-nuclear demonstrators wearing distorted masks and sporting badges and T shirts marched with children to Raj Bhavan in Bangalore. The marchers, organised by Citizens Against Nuclear Energy (CANE) presented a memorandum to the Governor A N Banerji against the plant, against mining at Arebail and against the nuclear waste disposal unit at Kolar Gold Mines.

A statement of public concern signed by 60 prominent citizens was also released on the occasion, noting alarm at the sudden spurt of nuclear related activities within the state.

Signatories included novelist U R Anantamurthy, Prof. Gopalakrishna Adiga, Dr. Siddaiah Puranik, Dr. Shivram Karanth and others. The statement demanded public hearings on the environmental impact of these activities and a national debate on nuclear energy. It also went on to demand repeal of the infamous Atomic Energy Act of 1962.

In the meanwhile, the nuclear establishment made repeated forays to disarm critics. R S Hegde, a prominent advocate from Karwar says he was called by a nuclear engineer for a discussion over two hours, in which the engineer tried to explain that nuclear plants were safeguarded from accidents. He says he grew suspicious when the engineer tried to convince him through some complicated equations that there was no "waste" at all produced by reactors like the ones planned at Kaiga!

Another nuclear scientist told activists that the Three-Mile-Island accident in the US that mothballed the reactor there forever was manned by "schoolboys". The Chernobyl accident was caused because of communism and obsolete nuclear technology. So continued the canards. At a public meeting in Karwar, Ramanna had reduced himself to a petty politician, promising the port town Rs. 20 crores for its development.

In the process, an arrogant Ramanna generated additional hostility when he attacked Shivram Karanth. "What does he know of science", a piqued Ramanna asked at a meeting. The remark angered villagers who hold Karanth in high esteem. Perhaps Ramanna was unaware that Karanth is the editor of a four volume science encyclopaedia in Kannada for children.

The Kaiga agitation was also responsible for Ramanna running away for the first time in his life. Scheduled to visit Bare, Yellapur and Arebail in the company of T N Seshan, Ramanna was told on arrival in the district that a large crowd of villagers was waiting to meet him at Yellapur and Bare. Terrified that the crowd had gathered to beat him up (when actually they wanted to discuss the reactors with him) Ramanna got back into his helicopter and flew to Shimoga where he proceeded to ask the Commission for police protection.

This did mean that the nuclear establishment's despotic days were finally numbered?

The nuclear lobby next tried to show videos in which MLAs like Rane and Deshpande were shown in processions shouting in favour of the nuclear reactors. Deshpande had earlier talked of the "Seven Mile Island" in Harrisburg, and the video had the reverse effect on people viewing it: both individuals were criticised because they pretended to know more about nuclear technology than their electors.

The Janata Party leaders remained firmly convinced of the need for the plants. The Janata MLA from Yellapur, A Hegde, said he had not made up his mind on Kaiga but had decided that nuclear reactors were safe. He was only playing

his usual games, since it is widely accepted that no person who supports the reactor will ever be elected again from the district. The Yellapur MLA told me that he favoured a "new solution" to nuclear hazards suggested by Soviet scientist Sukro, which he had read on a teleprinter while at the airport. This Sukro had suggested that all nuclear plants should be located under the ground. Kaiga too should be underground. It was only after persistent questioning that I discovered the man he was referring to was Sakharov.

In January, 1988, marchers participating in the Save the Western Ghats Peace March reached the Kaiga site. They were addressed on the occasion by the Swami of Pejawar Mutt. He declared that there should be a national debate, and till such time, work on Kaiga should cease. Otherwise, an Appiko type of agitation would be required, and if necessary, he would lead it himself.

In January 24, 1988, R V Deshpande himself was gheraoed by angry villagers at Malavalli, who asked him about the national debate. A frightened Deshpande rushed later to Hegde. Within a week, Hegde was again officially promising a national debate, "sometime in April". He then wrote a letter to the Prime Minister apprising him of the public resentment against the Kaiga nuclear plant.

On February 5, 1988, nuclear critics in Karnataka were sent telegrams by the Chief Minister asking them to come to Bangalore and prepare to join teams to the different nuclear reactors in the country and to reassure themselves that nothing was wrong with these plants. Teams left for Tarapur, Kota and Kalpakkam. They were met courteously at the plants, given dosimeters, and taken around. The team to the town of Jaduguda in Bihar, where uranium is being extracted, was still to leave at the time of writing. The teams which had visited the plants were busy preparing their reports.

But just as April approached, the month promised for the national debate, the Hegde government plunged into a political crisis. The survival of the government now took precedence over the survival of the reactors at Kaiga. By mid-April, when the political situation had stabilised, activists met Deshpande again and renewed their demand.

Wary however that the government might organize a sponsored debate, the agitators insisted that a steering committee be appointed which would organize the debate: they would nominate their own members to the committee.

The activists were also getting all Mandals panchayats in the area to pass resolutions against Kaiga, latest by the beginning of the monsoons.

In the meanwhile, the government is reneging on its own commitment not to go ahead with Kaiga till the population was reassured. The Nuclear Power Corporation is stealthily proceeding with its construction plans at the site. Huge bulldozers have been imported into the area, scarring and levelling the landscape. Culverts are being installed.

On a recent visit, I noticed that even the small wooden board that announced the village of Kaiga had been removed.

The activists, on the other hand, do not seem to be too concerned about this activity. They argue that at Bedthi too, government had put up buildings, which were later put to alternative uses when the dam was cancelled. The same could happen here.

Whether the agitation against the nuclear plants will succeed or not is still unclear. But it has already produced a number of concrete results.

It has also exposed the nuclear establishment to the populace as a bunch of mendacious, irresponsible individuals, unable to defend their activity, and always running to take protection under the petticoats of the Atomic Energy Act.

It has also shown that for the first time in the country's history, the fate of a nuclear reactor no longer lies in the hands of an M R Srinivasan of even the administration. It depends on ordinary villagers, in Kaiga, in Malavalli, Bare and others in the district. It has shown that schoolchildren, uneducated villagers, scientists, journalists, political activists can all get

together demystify nuclear realities, and form a formidable combine to stall the actions and plans of an unaccountable nuclear department. As the agitation begins to gather strength for a major assault in the days and months ahead, the world, already quite terrified by the mindboggling toxicity of nuclear energy, is going to watch their moves closely and with great sympathy.

Kaiga Interview - 3

Venkatramana Bhatt, is a farmer from Malavalli:

Q: What have you people decided to do against the Kaiga plant?

Bhatt: We have decided to hold a religious ritual on a big scale to stall the project. It is known as an athirudra. More than 100 pundits will participate.

Q: Why a religious form of protest?

Bhatt: We are expressing our feelings in terms of religion as we feel it is one important way of stopping this plant.

Q: Why are you opposed to the reactor?

Bhatt: I fear the radioactive effect on future generations to come. I am worried about it. I attended the Vajralli workshop. There I came to know the real dangers. So I have committed myself to oppose the plant.

Q: But haven't the meetings with top scientists like Ramanna been able to convince you that nuclear energy is safe?

Bhatt: No. Ramanna has failed to convince the local people here. Once he came to meet us, but when we all gathered to oppose him, he ran away.

Q: The authorities have already commenced constructing the infrastructure for the plant. What action are you taking about that?

Bhatt: When there is danger, and government is not prepared to hear our voice, it only strengthens our resolve to oppose the plant. We are committed to opposing it. We will do something.

Kaiga Interview - 4

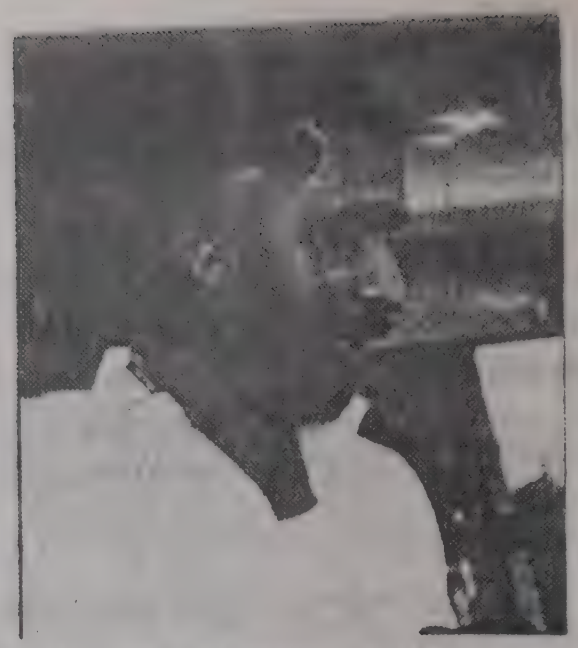
Mrs. Manorama K Gaonker, residing in Basal, member of the Zilla Parishad, and mother of three young children. She has been at the forefront of the agitation.

Q: What have you got against the Kaiga reactor proposal?

Mrs. Gaonker: We first heard of this plant being set up, in 1984 or early 1985 and by word of mouth we came to know of the hazards that such plants produce.

But it was the Vajralli workshop that really convinced me, and after it, I resolved to oppose the plant. Hundred per cent people in our constituency oppose it now.

Another thing we now know: the plant has a life of 25 years, but we will have to look after the waste and the remains which are radioactive for centuries, which makes it a very costly affair. Also you cannot expect much power from this plant. In any case, the power generated when compared with the dangers resulting from it, makes it a project that needs to be opposed.



Kaiga Interview - 5

Subbiah Dhogale, from Malavalli village, was part of the team that recently visited the reactors at Kota, between February 12-17, 1988, as an official invitee of the Karnataka Power Corporation.

Q: What did you think of the Kota reactors?

Dhogale: From what I saw, it was clear the Kaiga reactors would be of no use to this district. If at all anything happens, it will be only losses for us, no gains. The frequent shutdowns at Kota convinced me that no industry can be run on such a basis of electricity supply. Half the time the reactors were not working, and political pressures were brought to reopen the damaged reactor in time for festivals when extra energy was required.

Q: What are the other impressions you have of Kota?

Dhogale: Well we were surprised to see some fixtures held together by pieces of string! There is a big hospital there, but there are no patients. The hamlets surrounding the area are not part of nuclear development, and the people do not know anything about the reactor units.

The workers quarters have no facilities and all around is just like a slum. The authorities want to reduce the number of workers and are unable to do so, so they want them to get disgusted and go away by themselves. The workers are drawn from the Hindi belt and are not necessarily from around the area.

Of course, we did not get any satisfactory answer to our persistent questions concerning radioactive waste management.

Q: You don't think the Kaiga plant will benefit your area in any way?

Dhogale: So many projects are coming up in this entire area! We don't want this kind of development which disrupts our lives. We do not accept what government highlights as development. Our concept is different. We welcome development when it does not disrupt our socio-economic lifestyle.

Q: The Kaiga complex has brought you a road; you are also getting electricity from somewhere. Would you be willing to forgo things like this, if there is no Kaiga plant?

Dhogale: Naturally we like electricity, we find bus transport convenient, but we think there is scope for generating electricity from sources other than atomic reactors. And if an atomic reactor is the only way we can get these things, then we are willing to forgo even these comforts. We do not want these comforts if it means destroying our natural habitat.

Kaiga Interview - 6

Mr. B P Kadam, former Member of Parliament, and former Deputy Speaker of the Karnataka Legislative Assembly.

Q: What has been the response in Karwar generally to the nuclear plant at Kaiga?

Kadam: We were informed that the nuclear plant was a positive danger. Unfortunately, we could not get the intelligentsia on our side. Later we found out the reason for this: these very people had leased out their houses and flats to the Atomic scientists and they were having parties. The very people we were approaching were already in the pockets of the AEC.

Q: What are the hazards in your mind concerning the project?

Kadam: The Supa Dam catchment: that reservoir is 48 sq miles, and the water depth ranges from 200 ft to 200 metres. What do you think is the weight that this enormous quantity of water exerts on the land? The possibility of an earthquake is definitely there. In place of rock they found pulpy earth where they wanted to construct the dam: so they created an artificial foundation.

No less a person than Shivram Karanth has stated that there was already a major crack in the dam. He said it here at a public meeting and repeated it at another meeting in Belgaum. Not a single scientist contradicted him. An earthquake would provide a shock effect on the reactors, besides creating a flood that will inundate us all in Karwar taluk within a few hours.

We have other hazards. The Sea Bird project is also coming up here. Why concentrate everything in one place? We are not opposed to the national interest. In fact, we feel that the national interest itself is endangered by this. Why give our enemies a chance to do all this destruction at one stroke?

Q: Don't you need the electricity?

Kadam: Our districts are surplus in electricity. It is the Gulbarga area which is deficient. So have the project there and save the transmission loss. The transmission loss is estimated at 30%!

Q: You're not being assured by people like Ramanna and Srinivasan?

Kadam: Let the Government of India bring in other scientists and have a debate on the safety of these reactors. What is the use of Ramanna saying they are safe? He has a big budget to entertain those who are still sitting on the fence.

When we asked questions of Ramanna, he was very cavalier in his attitude and pompous. These scientists came saying they will convince everybody. I told them: you must also be prepared to get convinced if you are wrong. But they say we are using Goebbelsian tactics. Later, when there was another meeting at the Rotary Club, Rajaratnam, Srinivasan etc were all there. They could not satisfactorily answer a single question posed.

The DAE has gone to absurd limits to buy off the people. One person came to me and said that our mosquitoes will be a casualty of the nuclear project, because with the amount of money the authorities are planning to sink into Karwar, the nullah which breeds these insects can be removed. At a civic reception organised for him, Ramanna promised Rs.20 crores for the development of Karwar. By whose authority, may I ask? Karwar's development depends on the municipality and Ramanna has absolutely no authority to spend even a paise. But this is the way these scientists manage to get ignorant and even educated people on their side.

Kaiga Interview - 7

Prof. L T Sharma, 63, historian, is a retired principal of Sirsi College. He convened the Bedthi seminar which led to the scrapping of the dam on the river. From 1981-83 he was Information Officer to the Chief Minister of Karnataka. He is now associated with the Society for Environmental Awareness based in Kumta.

Q: What are the odds of your movement here succeeding in stopping the Kaiga project?

Sharma: The odds are formidable. The basic truth remains: if this plant is needed for power, whatever we have seen and heard of nuclear installations doesn't justify it. Power is to be generated at such cost, it is uncertain what the benefits are. It certainly will help neither industrialisation nor development.

One advantage they have is that the hazards associated with the reactors will not be visible now, but these are enormous and have not really been quantified.

Q: Would you mind giving some details of what you mean?

Sharma: In the absence of any health surveys in Bombay, Rajasthan, Madras, we can't say what is the total effect of radiation on human beings in those ares. Present measurements of radiation levels do not mean much since there is no base line health survey done. The effects of the warm waste water on organisms in the river has not been assessed: even a small difference of 2 degrees can destroy the riverine environment for fish.

The effects of radiation on the natural vegetation: the European experience is that there is a frightful impact on all vegetation windward of reactors. All these studies have not even been attempted by the atomic units. Clearly they are trading on our ignorance. This has to be exposed.

Q: What consequences do you forsee on the rainforests?

Sharma: We envisage gradual degradation. We have one single patch of rainforest in this area, the Anshi Ghat rainforest which is well worth preserving (in patches it is a biosphere reserve). If thousands of workers squat here to build the plants (as is bound to happen), degradation of this forest is inevitable. No arrangements have been made to permit casual workers to live in an organised fashion.

Apart from all this, note that this entire technology is a self-contained complex with no benefits for the population in the environs. The safety measures exist only for the reactors and the complex. Villagers are not educated to the dangers, they are kept in ignorance.

Q: The exercise is being done in the national interest. Who is to benefit from Kaiga power?

Sharma: We are told it will be fed into the southern grid, so we do not know where precisely it will go to. But certainly to the energy intensive industries of south Karnataka.

Q: Isn't it rather foolish taking energy so far?

Sharma: They say that an atomic energy plant can be located anywhere in the world, yet they select sites, which are sparsely populated. It would have been a service to have located the plant just outside Bangalore just to prove it is safe. But it is not so. The safety measures they take show that it is dangerous. So they are fully armed with precautions and operate in utmost security.

To the question whether it is in the national interest, my answer is yes and no. Our energy forms are diverse and leading us to a single form of energy will certainly be disastrous. But if it is for defence, then we want to know the details. Unfortunately, this matter is a closed book, secret. To live in a proclaimed open society with a centralised secretive network is a contradiction.

Q: What are the other implications of this nuclear project?

Sharma: The population is as I said totally ignorant. There is only one road to Karwar. The question of distress management, evacuation is inevitable. The plant area may be a no man's land, but the radiation area is populated. We are also in a seismic zone. That too is a matter of time, normal or geological. There are a number of dams still to be built in this area. What if one of them bursts? The proposed naval base is hardly 20 kms from here as the crow flies. Karwar will become a militarised zone and the culture and ecosystem will no longer be the same.

Q: You must have met the scientists. What do you think of their credibility?

Sharma: For three and a half years, they have been repeatedly saying that all is safe and that all safety measures have been taken. But the very fact that they are not ready to elaborate or take even the educated public into confidence raises doubts.

On occasions when they have been compelled to face the public, they have not been able to provide satisfactory answers. No doubt they can always sound confident in a public debate managed by a government agency because they can then shift into technical jargon and confuse the issue.

They refer to international standards followed in maintaining radiation levels but even the newly constituted Atomic Energy Regulatory Board has no teeth, no independent officials, only old hands deputed from the Atomic energy establishment. This clearly shows this is all empire building. All branches are under it, but they don't want to share knowledge or experience. Perhaps now that they are becoming a Corporation, they can be made more accountable.

Anyone who raises doubts however or who cites accidents is labelled a foreign agent!

THE ENVIRONMENT AT KAIGA

The Department of Environment & Forests was set up to protect India's environment, particularly against the ravages of projects or politics. Its role was essentially to estimate and analyse the environmental implications of development activity, to advise the government, to sponsor measures to conserve and strengthen the ecosystem.

Instead, what the Department does nowadays is to legitimise the further destruction of the environment. As its very department label goes, it sees the "environment" as distinct from "forests". And very often, because of this schizophrenia, it is willing to sacrifice the "forests", still hoping this will not affect the "environment".

In the case of the Narmada project, the Department estimated the environmental losses from the dams at a phenomenal Rs. 40,000 crores (for both Narmada Sagar and Sardar Sarovar combined). An ordinary state level economist working in Narmada Bhavan at Bhopal, redid the benefit cost ratio, by showing, with great imagination, that the two dams were actually going to raise benefits worth more than Rs. 50,000 crores. Nobody cared to see how he cooked up the figures. In an interview later, he admitted he had cooked up the figures. The Planning Commission accepted the exercise, and that sealed the fate of the Narmada river for the moment.

In the case of Kaiga, the DOEF did not even really try to stop the project. It was aware that the DAE had already begun to fell trees in the area without any permission whatsoever. The DOEF readily accepted the DAE's arguments that the sacrifice of an irreplaceable rainforest would be amply compensated by the power to be generated from the Kaiga reactors. Why then was clearance delayed?

The DOE had cleared the two reactors, but not, it said, the project as a whole, with all its attendant infrastructure, roads, colonies etc. Prior to his retirement, Raja Ramanna had wanted to gift his boys a new residential set-up that would rival the hill stations elsewhere. Ramanna wanted to place the staff colony high up at Bare in the midst of the rainforest, which was something he thought they deserved. The DOE objected to that. More important, even the villagers objected to that.

Eventually, when Ramanna relented and agreed to relocate the housing complex in Mallapur, the DOE cleared the project as a whole.

Wrote Bidwai later:

"The whole episode not only highlights the arrogant posture of the DAE - a characteristic of the department which has always resisted scrutiny by any other agency. It also exposes the sloppy nature of the system of environmental impact assessment that is prevalent even in respect of projects based on hazardous technologies. Kaiga is indeed a prime example of a project that should never have been cleared on environmental grounds."

This society has to decide on its commitment to the last remaining patches of untouched rainforest. These forests function as the lungs of the land, renewing the atmosphere, recharging the monsoon currents, retaining the downpour of the rains, discharging the streams and rivers of south India, conserving the soil and humidity, and harbouring not only varied kinds of wildlife, but retaining a rich depository of wild plants essential to modern agriculture. They also generate a much vaster quantity of living energy than the Kaiga reactors will ever do.

There is no way available as yet to estimate financially the enormous productive role of such rainforests, direct and indirect. We are carelessly frittering away a magnificent resource due to appalling ignorance.

The environmental clearance granted to Kaiga is a convincing example, if one is necessary, that the DOEF has been created to put a gloss over the official despoliation of the environment itself.

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Report

NATIONAL WORKSHOP ON NUCLEAR POWER PLANTS WITH SPECIFIC REFERENCE TO KAIGA

10 & 11 DECEMBER 1988

INAUGURAL SESSION

Ms.Neeraja Rajkumar, Secretary, Department of Science and Technology (Karnataka) welcomed the participants and speakers to the Workshop. She provided a brief background to the workshop and mentioned the former Chief Minister's desire to hold a debate on the issue. Mention was also made of the energy situation prevalent in the State.

Shri S.R. Bommai, the Chief Minister of Karnataka gave the Inaugural Address. He thanked the delegates for having accepted the invitation to the Workshop, on behalf of the Government and people of Karnataka. He said that this was the first such Workshop held after independence on a vital issue. While the country faced problems of illiteracy, poverty and unemployment, our shortcomings should be taken note of while planning for the future. He also laid stress on the urgency for modernising agriculture and for providing employment to meet the minimum needs of the people. The role of power in ensuring progress in the State was also emphasized.

The Workshop, he felt, should address itself not only to Kaiga but to the wider issue of atomic energy. Karnataka had initially accepted the Centre's proposal for setting up a nuclear power station at Kaiga. However, since a different view was expressed later, it was felt that a national debate be organised. Keeping the needs of the people in sight, atomic energy could be used if it were not harmful. He made an appeal to the participants that the deliberations be purposeful, and guide the nation in making decisions regarding the utilisation of nuclear energy. He hoped the intelligentia would move public opinion on the issue and aid and guide the government in the right direction.

In his presentation Dr.M.R. Srinivasan, Chairman of the AEC began by informing the delegates that over the last two years such Workshops had been organised in different parts of the country. He informed the gathering that there are presently 417 nuclear power stations in 26 countries. 16% of global electricity is generated through this route. The old Mysore State was a pioneer in hydel power generation. It was the first State to encourage power intensive industry. Dr.Srinivasan said that by 2000 A.D. there would be an additional energy demand of 10,000 MW. Since coal will become a critical resource, thermal power generation would not be the answer to the problem.

The selection of Kaiga as the proposed site for the power station was as per the criteria evolved by the AEC. The sites suggested by the states were evaluated objectively by multidisciplinary committees that included environmental specialists. The proposal to locate the plant at Kaiga was not imposed by the Central Government, but was the result of a joint decision taken by the State, the Centre and the AEC. Dr.Srinivasan also informed the gathering that there would be no uranium mining at Kaiga. Besides the area where the plant is to come up consist of 120 hectares of second grade forest.

Countering the charge that the developed countries were shutting down their reactors or reducing their dependence on nuclear energy, Dr.Srinivasan said that this was so not because nuclear energy was dangerous, but because these countries had other resources or low power demands. He stressed the need for power for rural areas and the agricultural sector. Developing countries, he said, need more power. Thus far no accidents had been reported from Rajasthan, where a power plant has been operating for 15 years. The problem of waste disposal could be tackled by reprocessing. He concluded by saying that all sources of energy must be simultaneously developed and hoped that the state prospers by using nuclear power.

Justice V.S. Krishna Iyer impressed upon the delegates the need to think in terms of the small is beautiful paradigm. The dialogue and discussion initiated by the State Government was necessary. Science, he felt, was meant for man and if nuclear power were to be equated with death, then there was no need for it. A number of countries all over the world were closing down their nuclear facilities. An awareness of these issues was essential for development. He felt that biogas plants in every panchayat could meet the energy needs of the people. The solar energy option was presently expensive since adequate R&D efforts had not been put in. Renewable sources should be considered as viable options.

He further stressed that nuclear power generation was fraught with risks. Nuclear power is to meet only 10% of the total power demand by 2000 A.D. This power can be generated from other resources as well, since the nuclear route had its risks. Scientists should assure the people that the process is absolutely safe. Secrecy concerning issues relating to atomic energy should be done away with. He made a case for freedom of information that would in turn facilitate judicious decision making. He closed by reaffirming the need for extreme caution in the use of atomic energy.

Shri J.H. Patel said that the State government's main concern was to help industry and agriculture. The element of risk was always present in every venture. Civilized life would have come to a grinding halt if power shortages were not bridged. He felt that renewable energy sources could not meet the demand. Thermal power plants could prove to be more harmful and unclean than their nuclear counterparts, and biomass cannot serve as an adequate substitute. Death on account of pollution should be weighed against the ill effects of unemployment and production losses. Shri Patel said that the power situation in the country, and the role of power in development are stark realities. He wished to know which energy source would meet this demand? If inevitable, the government will have to opt for nuclear power.

FIRST SESSION

ENERGY SCENARIO OF KARNATAKA AND INDIA - PROSPECTS FOR THE COMING YEARS

Shri S.G. Ramachandra provided a mid term appraisal of the Indian energy scenario, depicting the sectorial distribution of the projected electricity demand. Due to the long gestation periods of power projects and their role in providing essential infrastructure for employment generation in the industrial and services sector, planning for electricity assumed a critical role.

Hydro-power, Shri Ramachandra, pointed out could meet the peak load, but the base load had to be met either through the thermal or nuclear options. 10,000 MW of generating capacity should be added every year. Primary energy sources will turn critical around the years 2000-2010. The coal supply lines will come under high pressure and the oil bill exorbitant. Hence, a sound long term energy policy appears to be a must. Shri Ramachandra then discussed the Karnataka energy scenario, wherein he pointed out that hydro and thermal sources would not be sufficient. Nuclear energy will, he said, be vital for South India in order for it to become self-reliant in energy. On this count Karnataka will have its due share of central investment. He also pointed out that the safety measures at nuclear power stations are being constantly upgraded, and that safety regulations must be regularly enforced.

Prof.Amulya Kumar N. Reddy discussed the necessity of power from nuclear plants and its economics. He asserted that the consumption of energy per se is not an indicator of development. The deficit in projections of energy demand and supply were only apparent, and consequences of the assumptions and the simplistic projection methodology used. This deficit could be tackled by adopting conservation measures advocated by the Expert Group of the Economic and Planning Council. It followed from his analysis that the Kaiga nuclear power plant was not the only option.

Prof.Reddy also pointed out that AEC's assertion that nuclear power was cheaper than coal-based electricity was the fortuitous result of neglecting waste disposal costs and choosing favorable values for several parameters, such as using the discounted cash flow method and life-cycle costs. It was also demonstrated that the most uneconomical way of bridging these demand-supply gaps was through nuclear power plants. When environmental impacts were considered, the choice of options would be in the following order: conservation, decentralised renewable sources, centralised hydel, thermal sources; nuclear power be the last resort. He concluded by pointing out how our energy future was more a matter of choice than of destiny.

Shri S.L. Katti presented the salient features of the Kaiga project. The Nuclear Power Corporation had, he said, adequate experience in the design, construction, operation and maintenance of nuclear power plants. This also reflected the government's confidence in our engineers and scientists. In addition to the exploitation of alternate sources of energy, nuclear energy will, it was pointed out, have an important role to play. The demand for power in Karnataka would increase. Due to difficulties encountered in increasing the hydro-power potential, as well as the absence of coal deposits in the State, nuclear power appeared as a viable alternative.

The site at Kaiga, Sri Katti said, was selected after careful consideration, and was based on the opinion of experts from various agencies. The factors considered were briefly mentioned. The main site for the Kaiga power station lies in a degraded forest area. The felling of trees was reduced to a minimum, reforestation over about 4 times the area covered by the nuclear plant facility would be undertaken. The

disturbed families (85 only) would be compensated and rehabilitated. Steps were also being taken to train and recruit local people and provide them employment opportunities at the plant.

He also said that the additional radiation burden on the public would be negligible. An environmental survey laboratory would be set up to monitor the environmental impact. All safety measures undertaken came under the strict purview of norms laid out by the Atomic Energy Regulatory Board, and strict compliance with these regulations would be ensured. He hoped that the details provided by him would put the matter into proper perspective, and make it possible to draw correct conclusions.

Darryl D'Monte began by saying that the consumption of electricity was by itself not an indicator of economic growth. While India had the highest elasticity of power consumption among the poorer countries, the current pattern of industrial growth, based on big industries fed by power from highly centralised systems needed to be re-examined. There was a lot of scope, he added, for energy conservation in Indian industry. In addition to conservation alternatives, renewable sources of energy would also have to be used. Small scale, mini and micro hydel projects looked more favourable when hidden or discounted social costs of large dams were taken into account.

However, he felt that rural electrification was a fallacy, since most of the power was taken up by large industries. Centralised power generation would only benefit the industrial sector, while the rural areas would remain as they were. Centralised power systems would have to be supplemented by micro- hydro units in order to cater to rural needs. This was as much a political and social issue as a technological one. The very pattern of development would have to be reconsidered.

Prof.K.S. Jagadish viewed the electrical energy requirements and the potential of the biomass option from the perspective of rural development. He pointed out that 70% of the population of Karnataka residing in the villages received only 16.9% of the total power sold. This was due to centralised power generation and the prohibitive cost of distribution networks. Decentralised energy sources were a must if rural requirements were to be met. Urban and industrial power could be supplied by centralised power systems. The power potential of thermal and hydro options need to be exhausted before turning to nuclear power.

Prof.Jagadish asserted that biogas based power systems can supply 23 kW of power and 2.4 kW of motive power in each village of Karnataka. A higher quantum of power could be generated with better management of land and animal resources. On the whole, Karnataka could easily produce 640 MW of power by the biomass route. Besides, immense environmental and economic benefits would accrue by way of fertiliser production, soil and water conservation and employment generation. Nuclear energy, he said, did not provide any such beneficial fall outs.

Shri Vittal made a plea for the utilization of all the available energy sources. He said that the country was noted for its synthetic approach to all problems. While technologies depending on renewable sources of energy had still a long way to go before they could be commercially exploited, nuclear energy could be the technology of the first resort since it had already proved itself and the necessary technology and experience were available. He denied the findings that nuclear energy was costlier than thermal by citing international studies on the subject.

Discussion

The questions posed to Sri S.G. Ramachandra raised the following points:

Whether an independent assessment of demand, and mini and micro potentials had been carried out and whether the Ramachandra Committee had looked into the possibilities of increasing efficiency, implementing conservation measures and limiting transmission losses, all of which would make a difference to the projections.

As far as the assessment of the mini and micro-hydel potential in the State was concerned, it was mentioned that the KPCL had carried out an in-depth study. However, though the KPCL had the resources to carry out such a study Sri Ramachandra pointed out that it would be better if an environmental group conduct such an investigation . While projecting the energy demand for 2000 A.D he answered that conservation measures had been accounted for in his calculations.

Secondly it was pointed out that the responsibility for conservation had been delegated to the consumer. However, it was not certain whether such practices would yield any fruitful results. He also mentioned that there were schemes/incentives of the IDBI that encouraged industries to adopt energy conservation measures. However he was skeptical about the conservation due to the lead time involved.

With respect to the assumptions concerning transmission losses, he answered that the geographical distribution of power generation units and the end users are quite disperse. To a question posed by one of the participants to the effect that the transmission losses were just 9% in China, Mr.S.G. Ramachandra pointed out that in China electricity was generated in a decentralised manner and the end users were located in and around the source of electricity generation.

The questions posed to Prof.A.K.N. Reddy concerned the practical feasibility of adopting the conservation measures mentioned by him, the capital costs involved and the possibility of using LPG. The limits of efficiency and the toxicity associated with the manufacturing process of solar equipment were mentioned. The cost of a coal based plant at Kaiga and the related transmission costs were referred to. Due to the constraints of time, Prof.A.K.N. Reddy could answer only a few questions posed by the audience.

With regard to the conservation measures to be adopted, Prof.Reddy pointed out that it is possible to ensure energy conservation in toto. However the strategy for energy conservation should be based on the following principles:

1. Consumers not familiar with conservation measures should be provided with information, publicity, demonstration.

2. Consumers who know conservation but do not have front end capital may be provided loans, and these recovered in installments proportional to savings. At this juncture he quoted an incidence in the USA, where inefficient refrigerators were replaced by the most efficient ones by providing loans.

With regard to the efficiency of solar energy converting devices he remarked that, considering the progress made in the solar technology it was certain that the efficiency of solar devices will increase. This would be accompanied by a decrease in the prices. Towards the end he made it very clear that the energy

demand scenario arises from man-made policies. The projections will change depending upon the economic status determined by politicians.

Sri Katti's presentation provoked the following questions: the effect of a breach in the Supa dam and the proximity of the Kaiga Atomic Power Plants to project "Sea-Bird"; an estimate of the number of people likely to die in the case of an accident, Karnataka's share in the power produced. Claims that the plant would be situated in a degraded forest and the greenery prevalent around the RAPP plant were challenged. Details concerning the assessment of the site were sought.

Shri Katti said that the AEC was still evaluating the impact of a breach in the Supa dam on Kaiga. As to the estimate of the number of possible deaths in the eventuality of an accident, Mr.Katti stated that on many an occasion people drew comparisons with Chernobyl. Mr.Katti made it clear that the reactors at Chernobyl and the one at Kaiga were totally different. In response to the question concerning the criteria for the selection of the site, it was pointed out that factors such as ground water, cooling water availability, cyclone frequency etc. were considered. He also remarked that the Kaiga plant would require only 120 hectares of land located in a degraded forest, with teak plantation. However, the felling of forest will be kept to a minimum.

Darryl D'Monte's statement about per capita income and per capita power consumption was questioned, in reply to which he reaffirmed his position, substantiating his point with data reported in the literature.

Sri T.R. Satish Chandran who chaired the session, briefly highlighted Karnataka's energy scenario. He remarked that India had not yet reached the stage when the link between energy input and economic growth could be loosened. In particular, at the global the share of electricity in the total energy consumption will continue to grow. Karnataka had 5.8 percent of the total area and 5.4 percent of the total population of India. However it accounted for only 1.3 per cent of the country's coal consumption and 4.3 percent of the petroleum consumption, while being on par with the rest of the country in electricity consumption. Not only was the per capita consumption of commercial energy in Karnataka lower than the all India average, but the growth rate of consumption, during the decade ending 1985-86 was 4 percent in Karnataka compared with the all-India figure of 6.4 per cent. Among other factors, energy inadequacy had been responsible for the slide down of Karnataka's economy in the 80's, as evidenced by the fact that the per capita income in the State has fallen below the all-India average. While it was desirable to bring down the energy intensity of the economy, he pointed out that at the present stage of development of the country, the growth in the next few decades would have to be in the primary and secondary sectors of the economy. These sectors are relatively energy intensive. The continued high population growth rate has also contributed to the increased energy demand. The renewable energy technologies (given the then prevalent state of art) were expensive and were not suited to most energy applications. Even in the western countries, energy technologies have taken 50 to 60 years to penetrate the market. In a capital-scarce country like India, this process cannot be shortened. While agreeing with Prof.Reddy's criticism that energy conservation had not received adequate attention in India, he pointed out that even if a saving of the order of 25 percent were achieved, this would be a one- time effort and would not take care of the absolute increase in energy demand. He felt that, in the absence of coal reserves and the problems encountered in hydro-power development, there was a good case for setting up a nuclear power plant in Karnataka.

SECOND SESSION

RADIATION EFFECTS ON LIVING SYSTEMS

Dr.P.B. Desai was the first speaker of the session who began his talk by saying that "Progress has always extracted a price and nuclear energy is no exception". The speaker went on to show how nuclear radiation has been put to good use for therapeutic and diagnostic purposes in medicine. This was illustrated with a few examples. It was pointed out that man had evolved on this planet amidst a sea of radiation of which that emitted by nuclear power plants accounted for only 0.1%. The two types of exposures that occur were normally acute (that would occur in the eventuality of a nuclear holocast) and chronic (normally among radiation workers exposed on a long term to low levels). The "potential dangers" of chain exposure were described as:

a. genetic and chromosomal aberrations
b. sterility and infertility
c. increased incidence of cancers

The increase in the frequencies of these hazards for a population of a million people exposed to 1 gray radiation was as follows:

Risks	Natural frequency 10^6 pop	Addl.risks
a) Dominant and recessive mutation	12500	1500
b) Additional chromosomal damage in Igenesation	3400	200
c) Hereditary defects	90000	450

The exposure of the population following Nagasaki and Hiroshima did not reveal any significant clinical defects among the Japanese women studied. Such being the case it was difficult to identify genetic damage at low doses. Further the situation was complicated by the time lag between exposure and the onset of cancers (3 years in children and 25 years in adults).

Dr.Deivanayagam in his presentation opposed the threshold concept by quoting a WHO (ISU) report : "the generation of electricity through nuclear energy exposes the workers and general public to ionising radiations, and all exposures increase the risk of harmful effects". Explaining the different types of radiations (alpha,beta and gamma), the different types of exposures (acute and chronic) and effects (stochastic = statistical and not related to dose, and non-stochastic) he pointed out that any system of uranium processing is potentially dangerous. Even radiation used for early therapy caused several problems, especially among young women because all anomalies that could potentially develop from ova were present from birth. The speaker cited several examples such as the instances of increased polyploidy among Japanese fishermen, increased cancer risks among workers at Hanford, increased incidence of cancer among workers exposed to radiation in Britain and the Idaho Fall Repository. The speaker denied the adequacy of medical science to cope with radiation damage, citing the example of cesium induced deaths in Brazil. The safety of nuclear plants was also questioned. Dr.Deivanayagam pointed out that if a 2 foot thick steel and 6" thick concrete containment wall, with an inert suppression

pool at Chernobyl could cause such extensive damage (6 billion dollars financially) what would a double containment wall (two 3 feet thick concrete containment vessels) and rubble cope with? The speaker emphasised that radiation damage left a permanent memory in the human body and no amount of rest could overcome it. Further, since the effects of radiation were present from the lowest measurable dose it was not possible to eliminate the risk by admonishing those responsible.

Dr.P.N. Srivastava referred to radiation as yet another form of pollution, to which "the remarkable ability of our biological systems will evolve to adapt" itself and "only in the initial confrontation leads to devastation and the effects are diluted as the organism adapts". The LD_{50} for death in 2 months was about 400 rads. The effect on the population as assessed by the UN Committee and presented by earlier speakers was once again presented. The speaker also mentioned that the threshold concept had been abandoned. Referring to the Chernobyl accident the speaker cited (sources not mentioned) some four sources to say that the situation was as serious as one would fear.

Ms.Padma Prakash questioned the very concept of "relative risk" being used in the debate since it was based on many assumptions such as (i) risk is technology specific, (ii) risk is quantifiable and (iii) risk is of random occurrence. The absence of socio-economic determinants of the extent of risk (or vulnerability of sections of populations) and the lack of a baseline health survey in most reports generated questionable data. Further, since, no local sources of data were called upon in the debate the effort was meaningless and hence she urged the AEC and BARC to take up such relevant studies immediately, and if such studies did exist to release the same for public perusal.

Dr.Chauhan pointed out the terms 'safe' or 'toxic' have no connotations unless qualified with dose; implying that for any toxic agent including ionizing radiation or environmental chemicals, there is a toxic doze and there is also a safe dose. He reviewed the natural incidence of genetic diseases in man and said that chemical mutagens or ionizing radiation do not produce any novel effects but, beyond a certain dose may enhance the rate of spontaneously occurring disorders. He mentioned that the genetic apparatus of higher organisms has an inbuilt mechanism to ensure a high degree of "fidelity". He stated that extensive investigations in laboratory mice have shown no genetic effects at lower doses of ionizing radiation and have formed the basis for rriving at radiation risk estimates in man. Citing the Hiroshima and Nagasaki study, the speaker said that no evidence of any genetic effects had been so far observed. The speaker concluded his talk by stating that the human genome is probably four times less sensitive to ionizing radiation than that of mice.

Dr.V.T. Padmanabhan at the very outset questioned the validity of the data presented earlier such by the 'UN Committee on atomic radiation' as well as dat on the 'biological effects of ionising radiation', stating that all these bodies were directly or indirectly funded by bodies involved in nuclear power generation. The speaker delved upon four common hypotheses for the dose vs effect curves for radiation, and pointed out that atomic energy scientists and the protagonists of nuclear power in our country would not accept the zero intercept hypothesis before drawing conclusions from the 30 year old study being carried out in "High Background Radiation" (HBGR) Kerala.

The speaker also pointed out several abnormalities in the methodology used to arrive at "no effect" conclusions, from the above mentioned study and also pointed out the use of faulty data. The paper concluded with a poser to the BARC, as to why the scientists had not arrived at any positive conclusion following 3 decades of the HBGR study in Kerala, and why were they more concerned about emission of coal based thermal power plants.

Discussion

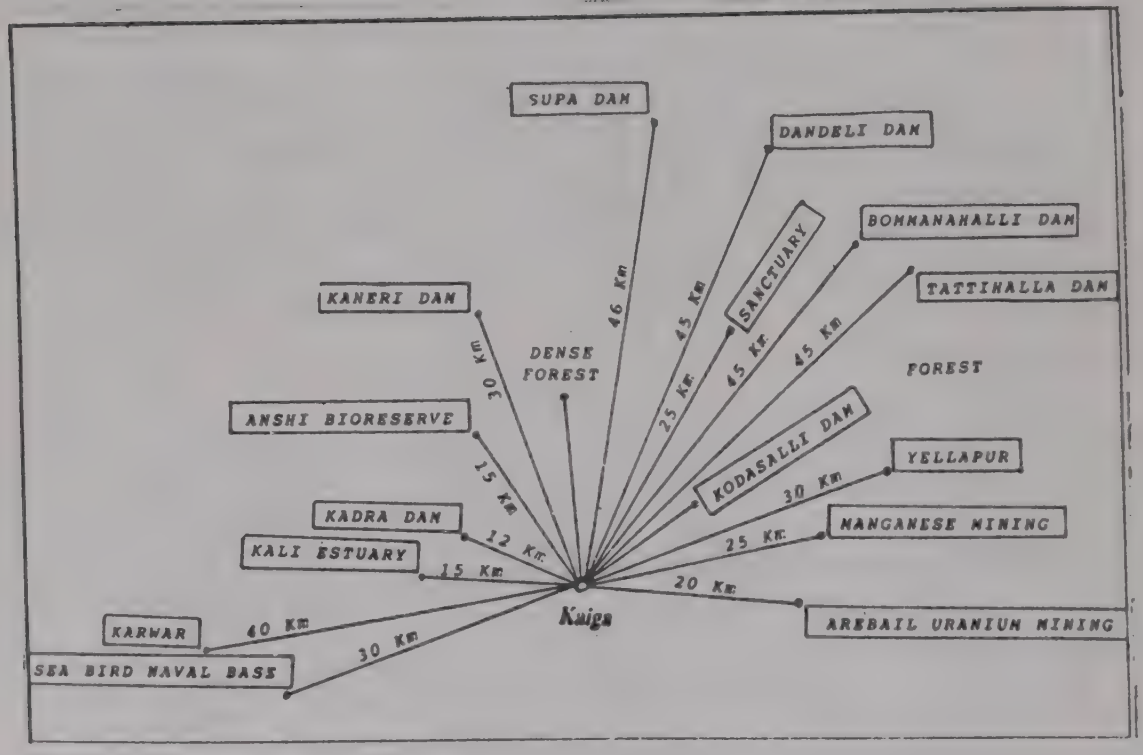
The Chairman reserved his remarks for the end of the session so that the discussion could proceed, and explained that any answer to a question could serve as a starting point for a discussion.

Dr.Deivanayagam, while responding to questions concerning the reliability of his source - Dr.Goffmann - presented the credentials of Dr.Goffman as a physician and a nuclear physicist. Responding to questions concerning the veracity of his statement that X-rays pass through living systems without having any ill effects, Dr.Deivanayagam read out the relevant portion from Dr.Goffman's book on "Radiation and Human Health": "X-rays and gamma rays which do not produce such effects as the photoelectric or compton effect, but go right through the body will have no biological effect at all. But alpha and beta particles intereact at every millimeter along their path through human tissue, guaranteeing biological harm". In response to another question concerning plans to monitor health and genetic disorders over generations and whether any data from Kalpakam was available, Dr.Deivanayagam replied that he had no data. He also said that he stood by his data, and that some workers at Kalpakam had been exposed to quantities of radiation exceeding 30,000 mRem. Replying to another question as to whether he used radiation in his work, he said that he did so by referring patients suffering from cancer for radiotherapy, and added that such patients do suffer from various effects related to the therapy. He also added that he had quoted Dr.Goffman because the latter's figures were at variance with the figures that other speakers had quoted, and that people had the right to know that there were other sets of figures.

Dr.Ramalingam wished to know wheter man was the most sensitive to ionizing radiation, and if man were safe, the entire biosphere would be safe. Dr.Desai said that it is not known whether man is sensitive to radiation - as man was among the most evolved organisms - but it wouldn't be correct to say that he was the most sensitive organism in the biosphere. Another participant asked whether long term exposure to low doses (of radiation) was more dangerous, adding that those killed instantaneously by radiation exposure were lucky. Since no one exposed to radiation and suffering from its effects could be lucky, Dr.Desai clarified that long term exposure to low doses of radiation could have ill effects, provided that such exposure exceeded permissible limits. Current data, he said, showed that if exposure remained below the permitted limits, i.e. 5 rem - the probability of developing either genetic defects, or cancer, was very very small. A participant commented that radiation pollution was several million times more dangerous than that caused by any known toxin. Dr.Desai replied that a great proportion of currently prevalent diseases resulted from man's lifestyle, habits and environment and added that he hadn't mentioned that radiation pollution from natural resources was very much more dangerous. A member from the audience raised the point that there should be no "low-level" for radiation at all, since there was no threshold radiation level. Dr.Desai said that zero level radiation was not attainable. He again clarified that provided the maximum permissible levels were not exceeded, current data showed that the exposure was not unsafe. Dr.Kusuma asked the speaker whether he agreed that there was no such thing as a natural cancer and that animals living in a "natural way" do not show any cancers, whereas humans who lived in a "most unnatural way" exhibited the highest incidence of cancer. The latter replied that while it was time that many cancers among humans were related to life styles, even animals - dogs, cats, mice etc., also get cancers - spontaneous cancers. Both domesticated animals - exposed to man, and wild animals develop cancers, he added. Dr.Kusuma commented that background radiation was not natural radiation, but also included the radiation from man-made sources - including nuclear weapon testing sites, and nuclear power plants. Dr.Desai agreed that this was true, but stressed that natural sources were responsible for the greater part of background radiation, and radiation from nuclear power plants accounted for a very ("infinitessimally") small proportion of the total background radiation. Another participant said that existing background radiation already posed a significant threat, and questioned the propriety of further adding to the hazard. The speaker replied that natural background radiation posed no hazard to man - as the immune system of human beings was such that most of them were able to live with it . Finally, responding to a comment that the risks of radiation couldn't be justified by comparing them with the risks from other hazards humans were exposed to, and that the approach should be to reduce all risks,

Dr Desai said that efforts were being made in that direction too (e.g. in campaigns to reduce tobacco use, etc.) and concluded by adding that the approach should not be of "one against the other", and that those who were for or against an issue were both equally important, as the presence of those against an issue would strengthen the resolve of those for the issue, leading to greater safety measures, and ultimately a further reduction of the subsequent risk.

The Chairman thus concluded the session by stating that functions and organisations become viable if there was a controversy, and if the controversy was kept alive by a mutual exchange of ideas - each side trying to understand the others' point of view.



THIRD SESSION

EFFECTS OF THE NUCLEAR POWER PROJECTS ON THE ECO-SYSTEMS WITH SPECIFIC REFERENCE TO KAIGA

Mr.Nagesh Hegde started by thanking the Government of Karnataka and the AEC for organising the debate. He was of the view that the AEC has come a long way in encouraging such a debate. He said that there was a proposal three years go to hold such a debate at Max Mueller Bhavan, Bombay. However, the external affairs ministry rejected the proposal. He stated that his presentation would be based on whatever little information had been made available by the AEC. Citing the 20 page document handed out by the AEC, Mr.Hegde mentioned AEC's awareness of the prevalent economic activity in the area around Kaiga. The document said that "the main activity in the Kaiga environment is large scale fishing, and this has been taken note of in setting up authorised limits through the relevant pathways". The speaker was of the view that the concern voiced in the report was highly inadequate when the future of 5,000 families of fishermen was in question. He traced the forest cover in the past to about 80% of the land area, that had since been reduced to about 8%. He attributed this loss mainly to the following:

a) major dams and hydel projects that had resulted in the submergence of thousands of hectares and the loss of some hundreds of hectares for the rehabilitation of the affected.

b) the industrial sector, primarily the paper and pulp industries which have denuded the bamboo and softwood plantations.

c) manganese mining activities which have resulted in large tracks of barren land.

In setting out on all these activities the effects of soil erosion or the destruction of forests had not been taken into consideration. He was of the view that the rehabilitation of natural resources had never been taken cognisance of, in these projects. He quoted an instance related to hydel projects wherein there had been excessive cutting of trees in an area that was not submerged, while trees in the submerged areas were left in tact. He said that more than 10,000 people had been displaced from Uttara Kannada and a district of plenty had become a district of refugees. He further opined that the environmental impact was not limited to the geographical entity that housed the project, but went much beyond that. He enumerated the various types of emissions incumbant to a nuclear power system:

a) gases containing radioactive materials like Krypton, etc which spreads over hundred kms;

b) heat emitted, which is equivalent to twice the power generated.

c) heat transferred to the water that could affect aquatic breeding grounds.

The speaker questioned the proximate location of both the Kaiga nuclear plant and the Sea Bird naval base, saying that the risks would mutually reinforce each other. The speaker was concerned about the status of the land housing the power plant at the end of the nuclear plant's life. He said that unless the scientists were sure of returning the site in its original productive form, there were serious objections to setting up the plant in the first place. At this point he criticised the environmental impact assessment report drawn up by the AEC saying that questions as to of how the reactor would be decommissioned at the end of its useful life, etc. have not been discussed at all. He quoted Dr.Saffiullah's conclusions and said that the entrance to the proposed project site was not necessarily devoid of forests in all directions. Mr.Hegde said that degraded land at Kaiga was a result of, among other things, an experiment by the forest

department wherein eucalyptus plantations were tried out. The exercise failed due to the onset of the pink disease. Stressing the fact that conserving a biosphere consisted of far more than growing trees, Mr.Hegde said that the diversity contained in the biosphere of Kaiga is inadequately appreciated by the scientific community. He expressed his apprehensions concerning the fate of nearly two lakh people sustaining themselves on agriculture and horticulture. This was illustrated by the case of Japan where nuclear scientists were very secretive, and hence the people had taken recourse to their own docimeter in the form of a spiderwart flower which is highly sensitive to radiation. He further said that the work on Kaiga should be preceeded by a literacy drive in order to educate the local people. The instance of Tarapur was cited, where the farmers were given pamphlets which they could not read. A brief presentation of a number of projects within a radius of 50 kms around Kaiga was also made. He gave instances of Anshi Bio Reserve and the Dandeli wild life sanctuary that are located in the vicinity of Kaiga, and pondered on the impact of radiation on the flora and fauna in these areas. Mr.Hegde was sceptical about the AECs generalised statements and its concern for environmental issues.

Dr.Soman compared the land utilised per MW of power output as follows:

Type	Ha/MW
Hydel	18.6
Nuclear	0.06
Thermal	1

He said that accidents are inherent to power generating systems and it was not as though this feature was limited to nuclear power systems. Comparing the impact of thermal effects on the ecology, he said that on considering one kWh production, the heat released into the atmosphere was higher for thermal power plants than for nuclear power plants. According to him most of the heat discharged into the atmosphere was through water bodies. Elaborating on the thermal emission. A meteorological station close to the Tarapur nuclear power station has been recording data since 1961. Presenting the annual average of hourly readings taken, he observed that there was no significant difference in the temperature since the commissioning of the power station. He opined that the thermal effects on the aquatic environment was confined to a 'single pass sytem'. Water from the intake, ran through the process, undergoing a temperature rise of about 8-9^{o} C in the condensor and was then let out into the water body through a canal. The momentum of the water caused mixing at the contact point. He observed that at a distance of 50-100 mtrs from the contact point the increase in temperature above the surface water temperature was about 1.5 - 2^{o} C only. At a distance of about 500 mtrs the temperature rise was about 0.5^{o} C. According to him the inversely proportional relationship between DO and temperature was the main cause for the debate on the impact of an increase in temperature. He observed that the waters were seldom saturated with respect to oxygen. Moreover during the flow of water through the condensor there was a turbulent flow and flow mixing as a result of which no significant decrease in DO was observed between the pre and post condensor stages. He further observed that the DO levels at the contact point were the same as elsewhere in the water body. He pointed that there was total loss of plankton between the intake and discharge canal, though he felt that this could primarily be due to impingement, at a distance of 200-300 mtrs from the contact point. However the plankton count was the same elsewhere in the water body. Thus he concluded that the thermal effect on water bodies was confined to a distance of about half a kilometer from the contact point. Elaborating on the radiation he observed that the lower organisms were less susceptible to radiation effects when compared with mammals.

The principle pathways through which radioactivity is released into environment is through soils, plants, animals, water, air etc. He observed that soil had a great fixing power for such elements. Similarly in water bodies the sediments with high risk KD factors pick up most of the radio nucleoids. Laboratory experiments had shown that even in a highly radioactive solution of Cesium 137 the division rates of cells were not effected. ICRP has allowed an exposure upto a maximum of 100 milli R/yr. Comparing this with the radioactive emissions in the power plant's perimeter, he said that the Tarapur plant emits a radiation of

about 20 milli R/yr, while the plant at Rajasthan emits less than 5 milli R/yr. The Kaiga plant is expected to have a radioactivity of about 1-2 milli R/yr because argon 41 will not be emitted. Averaging the above figures over a five kilometer zone these values would decrease further,so much so that at Kaiga the radioactivity would be of the order of about 0.5 milli R/yr.

Discussing the possible eventuality of accidents, he quoted the NRPB report and observed that even at a distance of 1 km, radioactivity would be in the range of 1-10 REM. He observed that the emmisions from thermal power plants were as carcinogenic as emmisions from nuclear power plants. Epidemiological studies carried out by several agencies in various countries had not shown any correlation between cancer and the environment around nuclear power plants, albeit, in England certain occurences of leukamia had been traced to the existence of radioactivity.

Prof.Shivaji Rao commenced his presentation by saying that preliminary risk analysis and environmental impact assessment of nuclear power stations was a very important component of the project feasibility study. He further said that he had carried out such an exercise for Kaiga and the Nagarjuna Sagar Nuclear Power Plants. Basing his findings on the reaction of international experts like David Lilenthal (Three Mile Island, 1979) and Alvin Weinberg (Chernobyl, 1986), he said that all existing reactors were inherently unsafe and hence dangerous. He proposed a moratorium on the further construction of nuclear plants until safe reactors were designed. He said that such reactors had already been designed in Germany and Sweden and their financial viability was under examination.

Discussing the safety of nuclear reactors he said that the length, surface area and complexity of primary systems resulted in a greater probability of loss of coolant accidents, which coupled with scram failure lead to the rapid melting of fuel and possible common mode breach of containment. He said that since the containment could not withstand large scale zirconium-steam reactions, hydrogen vapour explosions, common mode rupture of primary and secondary coolant systems, human failure, sabotage, missile hits, terrorism, bombing, plane crashes etc., it was not possible to say nuclear power was safe.

He felt that although the nuclear experts were very careful, one was apprehensive of the performance of their blue prints developed in the technological paradise of the real world. He further said that radioactive pollutants were highly toxic and dangerous because they could not be detected by normal physical senses. Hence any increase in radioactivity beyond the background level is considered harmful. In order to minimise radiation ICRP recommended the 'ALARA' principle ("as low as reasonaly achievable). This is possible if the reactors are located underground. In fact Soviet and Israeli experts have suggested locating the reactors about 110 mtrs underground, while Norwegian and Swedish scientists advocate locating reactors in rock caverns. Commenting on the proximity of Sea Bird and the Kaiga project, he said that both would mutually threaten each other. Based on Westinghouse studies (110 MWe pressurised water reactor, East Coast, England) on accident scenarios and the subsequent modelling as advocated by NRPB, the population has to be evacuated to a distance of upto 170 kms from the reactor. Applying the scenario to Kaiga he opined that depollution and subsequent evacuation to a distance of 95-100 kms. The inhabitants could return only after 20 years. Defining risks, he said that these could be estimated as the probability of an accident multiplied by the damage costs of such an accident. Since 1956 many studies quantifying the socio-economic costs of nuclear reactors have been carried out. In the first study it was estimated that there would be 3400 deaths, 43,000 injuries and damage worth 7000 million dollars at 1956 prices. A second study had estimated 45,000 deaths, 1 lakh injuries, and 17,000 million dollars worth of property damaged. A 1973 British study had conciuded that socio economic costs of an accident would be of the order of 600 million pounds. After the TMI accident a study on all 80 reactor sites in USA was carried out, and it was concluded that in the worst case the socio-economic cost would be 314,000 million dollars. He quoted the PRICE ANDERSON ACT of USA according to which the people have to be compensated in the case of loss of life and damage to health due to a nuclear accident. The amount of compensation was about 560 million dollars, which had recently been raised to 7000

million dollars. He emphasized that a similar act should come into being in India too. Commenting on the probability factor, he said that contrary to MIT figures of 1 accident in 1 million reactor years, the actual figure based on an analysis of TMI and Chernobyl is about 1 in 2000 reactor years, implying that the probability is about 500 times higher than figure projected by MIT.

Dr.P.K. Iyengar initiated his presentation by emphasising the credibility of nuclear scientists. He discussed the origin of the earth and the development of nuclear science. He said that the man is living on Earth which itself is a nuclear waste by nature. However, because of its age, there are very few radioactive elements present today. He associated exponential decay with the concept of probability. Illustrating his point he referred to an earlier speaker who held that gamma rays pass through a human body. According to Dr.Iyenger this in itself had a low probability since the statement was true only in the case where the gamma ray did not collide with an electron in its path. Commenting on the utility of defining the accident susceptibility of a particular system, he said that, this could be a pointer for judging the relative merits and demerits of a system and hence should not be taken literally. Rather they were taken into effect when economic calculations were carried out. Discussing waste disposal, he initially acquainted the audience with the common radioactivity encountered. He went on to say that radioactivity varied by factor of 100 across Maharashtra and Kerala, and both are inhabited places. The nuclear power generation system, he said, consisted of a cylinder containing heavy water and having about 300 tubes which in turn had fuel elements. The conditions are so optimised that the heat energy produced was removed by heavy water that in turn produced steam used for running turbines. Hence he was of the view that from the turbine the ecological disturbances if any, were the same as for other power generating alternatives, implying that the pollutants were limited to the cylinder only. Radioactive discharge arises on account of the neutron flux produced by the fission reaction. Therefore the neutron flux tends to activate the sides of the vessels. Water or air passing through can thus be activated. In the case of Kaiga some modifications had been made in the design, so that argon emmissions were avoided. The energy generating unit consisted of fuel bundles, about 1/2 mtr in length, each containing fuel elements. Inside the zirconium tubes were the fuel pellets made up of uranium oxide. He asserted that no radio- activity from the fuel pellets normally escaped into the environment or into the heavy water. Studies have shown that the probability of a fine hole appearing is one in 10,000. Hence the radioactivity produced was contained in fuel bundles that were taken out and submerged underwater in a pool. After 4-5 years they would be taken to a reprocessing plant, that would not be located near Kaiga. Radioactivity waste management, according to him, was thus related to the operations in a reprocessing plant. So far as the power station was concerned, low level waste produced was treated either with cement concrete or bitumen and stored. He further said that adequate care had been taken to ensure that the drawbacks of Chernobyl were overcome at Kaiga. In fact a disaster management committee had been set up, that would go through safety committee reports and recommend action. He further clarified that the decisions of international bodies like the International Atomic Energy Agency and International Council for Radiation Protection etc., served as a basis for the work carried out by Indian scientists.

Dr.A.N. Nagaraj was concerned that byproducts of nuclear reactors were more toxic and dangerous than nascent uranium. He pointed out that a Kaiga size reactor used about 952 tonnes of uranium producing an equal amount of radioactive byproducts. This reaches men and living beings through air, water and food material. The radioactive rays consisting of alpha and beta particles explode in the cell, destroying cell structure and the DNA that determines genetic inheritance etc. Discussing problems of the storage of radioactive waste materials, he cited the example of Lyons, Kansas, where holes of 300 - 1200 metres deep were drilled in order to bury the waste. During the process of burial a destabilization of the substratum was observed, as evident in a split that drained out 17,500 gallons of water. This implied that radioactivity destabilised the geological substratum. Citing another example from Hanford, Washington, he said that 400,000 gallons of radioactive waste had leaked into the environment, and a layer of plutonium had formed at the storage facility. This could have resulted in a massive radioactive spill, had it come into contact with water. Reactions of various substances in stored waste were not yet understood, and could result in explosions as in Kushtym, USSR. Besides Kaiga will produce 3800 tonnes of used fuel apart from

thousands of tonnes of low level wastes and contaminated machinery and pipes that would have to be stored for long without polluting the environment. Further, he said that human error and failure of machinery, which account for most of the accidents, would very well occur in India. The radioactive spillage following such accidents results in cancers over several generations.

Dr.Safeeulla agreed with Mr.Nagesh Hegde's contention that the ecology and environment of Western Ghats had been greatly undermined. He went on to say that his four decade old association with the Western Ghats had witnessed considerable degradation of flora and fauna in the region. His report, he stressed reflected no bias in his judgements since the inspection of the sight was purely as a botanist and ecologist. Reading out his evaluation report on the Kaiga environment he made the following points:

- There are no natural forests on the way to and in Kaiga.
- The proposed project was located in a teak wood plantation raised for commercial purposes.
- There was a small area of regenerated forest close to the construction site.
- To the north of the site the forest had been cleared as this would be submerged for an irrigation project.
- The trees had been cleared long before the site had been selected for the purpose of the Kaiga project.
- In all about 3000 10-15 years old teak plants would be cut from the project site and given to the forest dept.
- A road leading to the power plant was being widened.
- The area where quarters for the officers were being built had no natural forest.
- The damage at the proposed site was no more than the damage caused during the building of goods, dwellings etc.
- The environment leading to and at Kaiga was not polluted.

Dr.Safeeulla made some recommendations that are recorded below ad verbatim:

- The flora and fauna count should be worked out.
- Identify the botanically important species in the site and the surrounding areas.
- Collect seeds and herbarium species of important and rare species to be presented in the different parts of the country.
- Establish a forest nursery consisting of forestry especially peculiar to the Western ghat species.
- Protect the existing regenerated forest close to Kaiga.
- Monitor air and water pollutants. Monitor the levels of radiation in plants and animals.
- Introduce index plants specially sensitive to water, air and nuclear pollutants.

Prof.Anand Swaroop Arya, Roorkee discussed the seismic effects on atomic power plants. He initiated the discussion on the seismic pattern near Kaiga as shown below:

Seismic effects:

Existing seismicity:

M = 4.0	150 km)	SE of Kaiga site
5.0	280 ")	
5.0	380 ")	
M = 4.0	130 km)	NNW of site
3.0 +	280 km)	
4 to 6		
M = 3.5	100 kms)	NE & NNE of site
M = 3.8	20 kms)	E of site
M = 4.5	130 kms)	SW of site

He thus concluded that the highest seismicity observed closest to Kaiga was about 3.5 on the Ritcher scale. However, the seismicity used for the design of the power station was 6.5 on the Ritcher scale at a distance of 20 km from the site, that would release about 180 times the energy of the earthquake of intensity 5.0 on the Ritcher scale.

Design seismicity

M = 6.5 is 20 kms from site

2 PA = 0.2g S_2 or SSE

e.g. 6.5 is about 180 times of M=5.0 quake

Commenting on the response of the structure to the earthquake waves, he explained that the response spectrum took account of the flexibility of the building with respect to the time period. The ground acceleration factor would be different for different structures, e.g. short and rigid, long and flexible etc. The behaviour of the structure at a given site during a given earthquake is thus a function of both the ground waves as well as the structure. Seismic safety for a building free from hazards was defined such that the co-efficient of seimicity would allow for some damage though the structure would not collapse. However,even for the most probable earthquake the structure of atomic plants would remain perfectly elastic and would not develop cracks.

Dr.Shivaram Karanth began by stating that the site of Supa dam was decided upon even though the satellite photograph revealed a fissure in the rock at the site. The water stored in the reservoir could cause an imbalance, which could precipitate in an earthquake. He then went on to raise doubts regarding the location of the Kaiga power plant that was in the vicinity of the Dharwad fault plane that extended upto Koyna. He voiced his concern over the danger of embrittlement of metals used in the circulatory system of nuclear plants and the associated radiation effects. He opined that the views of the majority of public to be affected by the power plant should act as a pointer for further action, which in this case was not to go ahead with the nuclear power plant at Kaiga. Referring to the Three Mile Island report he said that 30% of all disasters occur due to human error; this was very likely in the Indian context.

FOURTH SESSION

NUCLEAR POWER PLANT SAFETY

The session was chaired by Prof. Satish Dhawan, who broadly defined the terrain for the discussion on nuclear safety. He felt that nuclear safety incorporated the following four dimensions :

1. Safety during the running of the plant.
2. Safety measured in the event of an accident
3. Post accident safety measures and
4. Evacuation measures.

Safety devices were technically fallible and so were the people who manned them. Hence, it was necessary to design inherently safe systems based on physical principles. The first paper was presented by Dr. D.V. Gopinath from IGC. He began by saying that nuclear technology, like any other technology is not absolutely safe, but the important task was to weigh the performance of technology with respect to the risks involved and to compare the risk involved in different technologies to derive the same benefit. Most of his presentation was concerned with safety measures and calculations with respect to existing reactors. The principle concern for safety calculations and analysis had to do with the associated radioactivity and ionising radiations. Since the fission products were radioactive there were three principle segments exposed to these radiations. These include the personnel working at reactor sites, the public living in the proximity of reactors and the environment. The method adopted for studying the safety characteristics of nuclear installations was the 'defense in depth' scheme which is a multi- layered approach. There were a number of control and protective systems at various levels and depending on the severity of the consequence of failure, a commensurate redundancy of the control systems is provided. Hence, there is a very low probability of all safety systems at any one level failing simultaneously. The other important aspects include reliability, that ensures the mean time between failure(MTBF) of all systems is well cross checked before any system is accepted. Quality assurance was also impressed upon, followed by health inspectorate studies concerned with the safety of the man behind the machine. The safety analyses committee recommends that power supply for safety systems come from three different sources; these include an emergency diesel supply and an uninterrupted power supply system. The safety cooling system is also a multi-layered one which included 8 PHT pumps, auxiliary feed pumps, steam blowers, moderators and fire water injection systems. Multiple barriers were set up for containing radioactivity. These include a ceramic fuel container that provides a matrix to hold the fission products, a zircalloy container in which the fuel is hermetically sealed, a PHT system , a third barrier and the containment building. The leakage rate for the building for the worst case scenario was estimated to be 0.1% /hour. The building is enclosed in a secondary containment building and the interspace is continuously monitored for leakage. There is an exclusion zone of 1.6 km and a controlled zone which covers a radius of 5 km. Three independent safety committees carry out an evaluation in series at every stage; these are the : (1) Site selection, (2) reactor design and construction, and (3) commissioning and operation committees. An analysis of all earlier possible accidents was carried out. The worst accident probability is $1/10^6$, for which the impact on health is a minimum. Cognizance is also taken of public health effects. These risks are compared with the risk involved in power generation by other means and it is found that man days lost due to injuries and fatalities per MWe generated are an order of magnitude less. At Kalpakam some caesium was released in to the environment. It has also been found that between 1974 to 1988 there was an insignificant alteration in the quantity of Cs 137 released in to the sea. The quantity of gaseous and liquid materials released is also negligible. An aerial survey of radiation background of the environment revealed that the quantity of argon-41 released at Madras Atomic Power Station was higher than other

radioelements, though it was well below permissible limits. However, this will not be true of the reactor intended to be set up at Kaiga. An aerial survey around Kalpakam revealed that there are high background patches due to monazite, but there was no perceptible increase in radiation background released from the reactor. Dr. Gopinath claimed that nuclear power seems to be the safest in terms of the pollutants released in to the environment. He claimed that the hazard potential of chemicals released by other modes of power generation was an order of magnitude higher than that of nuclear wastes.

Dr. Vishnu Kamath began his presentation with the assertion that nuclear reactor safety was really a small part of the larger concept of the nuclear safety. However, his presentation was concerned with those Indian reactors based on the CANDU design. His analysis was based on data from the Canadian CANDU reactors. The Canadian reactor was a pressure tube reactor having 19 elements in its fuel bundle Even this design suffered from a number of drawbacks. Since CANDU reactors had a larger surface area they involve single pressure vessels. Secondly, the large neutron flux caused a weakening of the pressure tubes. Thirdly, the process involved a higher inventory of tritium. The excessive use of zirconium in the zirconium steam reaction caused it's own set of problems. The rule of thumb that a "leak precedes break theory", which implied that a detectable leak would sound the alarm of an impending breakdown, had failed in this case. Finally, the fueling machines used these days precepitated a new set of accidents. He then went on to discuss the accident tree diagrams for CANDU reactors and the failure rate in emergency cooling. In the Canadian reactors there had been a serious loss of coolant accident (LOCA) as a result of which the units had to be shut down. In some cases emergency cooling had failed at the required moment. He also calculated the probabilities for accidents (LOCA) and meltdown for single and many reactors both, annually and over a life time. The calculations revealed that the probability of a LOCA occurring in one of twenty nuclear reactors over a life time was of the order of 98%. He said, however, that the calculations were performed for recent CANDUs, whereas the Indian CANDUs were pre-1974 designs. He wished to know whether the Indian scientists manning these reactors had performed similar calculations and had the Indian reactor fared any better.

Dr. Surendra Gadekar's paper dealt with additional safety problems that the Indian nuclear programme had inflicted upon itself over and above problems commonly encountered in reactors around the world, which had been discussed by the previous two speakers. His contention was that the absence of a critical expertise independent of DAE control, itself constituted a safety hazard. The commission investigating the Three Mile Island accident in the U.S.A. had concluded that the 'nuclear mindset' - 'the it can't happen here syndrome' was the single factor most responsible for the accident. Therefore, Dr.Gadekar stressed the need for the development of independent nuclear expertise and the necessity of free flow of information, as a prerequisite to that end.

The other problems pointed out by him dealt with the absence of a standardized design for Indian reactors. India had four different kinds of power reactors and the experience gained in operating one kind did not help in tackling problems arising in a different kind. There were also special problems due to aging reactors. This was of special relevance to Tarapur. Another drawback in the Indian nuclear programme was the fact that the mainstay of the programme was the CANDU reactor. Worldwide there have been very few CANDU's. Hence the number of reactor-years of experience and safety research on them has been very meager. Quoting extensively from the Prasad Committee report which had enquired into the poor performance of the Rajasthan Atomic Power Project, Dr.Gadekar said that Indian reactors had been operated hazardously in the past. According to the Prasad Committee, of which Dr.Srinivasan himself had been a member, the pressure of keeping the reactor running had prompted the management to disregard safety norms. The committee had also commented on the poor morale in the Indian nuclear establishments and the high rate of turnover of reactor personnel.

Dr.Gadekar ended his talk with a plea for free flow of information. He demanded the immediate release to the public of internal reports, for example, the Sriram committee report on Tarapur, the Ramarao

committee report on Rawatbhata and the Vengurlekar committee report on site selection. He also desired that the DAE make some site specified risk analysis. Finally, he felt that DAE has not sufficiently educated the Indian public with respect to its nuclear power projects.

At this juncture the chairman interjected and said that it is not necessary to pick fault with the hard working Indian scientists, rather one must create a pressure on the Government, to take the Indian people in to confidence. Secondly, he said that there was no point in drawing a comparison between nuclear accidents and other accidents such as road accidents, instead, complex questions should be answered. Thirdly, he pointed out that though there is a very real nexus between nuclear weapons and nuclear power plants, however, modern science is quite reconcilable with the harmonious regulation of human life.

Prof A.K.De spoke as the chairman of AERB, which he said was a regulatory body and therefore it is not pro- or anti-nuclear. The AERB was independent of DAE and liased between the scientists of DAE and the Indian public. The AERB had insisted that a 1.6 km exclusion zone be marked out as required by the worst case scenario. This was calculated for a maximum radiation exposure of 10 rem for the whole body and 50 rem for the thyroid. A 5 km zone had also been demarcated where the population density was very low and a third outer zone of 15 to 16 kms with a population of 20 thousand people. The objective of the AERB was the preparation of safety codes and guidelines; supervision of authorised construction and commissioning of nuclear power plants and the surveillance of such facilities under construction and operation. The AERB was also assigned inspection functions such as quality assurance and quality control, the regulation of fuel loading, heavy water addition and inspection before the plant achieved criticality. It was also assigned the task of verifying technical specifications and providing special information to specific problems. Besides, these tasks the AERB was also to ensure defence in depth, such as assuring the standard of highly trained staff, provide instrumentation and control facilities to affect safe shutdown, analyse nuclear accidents throughout the world, and finally, to provide additional safeguards. He also seemed to make the point that nuclear power is the cleanest power. The AERB has defined its safety goals as follows:

1. To protect the public from hazards of nuclear power.

2. Reduce the risk to 0.1% of the sum of prompt fatality risks due to other accidents.

3. To ensure that social risks are minimum and far less than that incurred by other technologies.

4. Reduce the risk of cancer for those living in the proximity of nuclear power plants.

The chairman wished to know what stand had AERB taken on Kaiga. Prof De informed him that the selection of the site itself did not come under the purview of AERB. Once the site had been selected the AERB would take a decision.

The last presentation was from Dr.C.S.G. Prasad from Madras. He commenced by saying that a viable dialogue had not been setup between the two parties. Whereas they were problems with the nuclear fuel cycle, there were more pressing problems relating to the routine operation of nuclear reactors. Data relating to the earlier years of Indian atomic energy projects revealed that the radioactivity released from Indian nuclear reactors, particularly, liquid and gaseous discharges, were far higher than the actually announced values. The routine discharge of nuclear waste was very high. At RAPS, the number of man-rems/year was found to be substantially higher than that released any where in the world. Similarly, one has not yet seen a paper on the operating experience of RAPS and data related to the routine safety

procedure. He also pointed out that a report containing these data must be made available as a routine matter. He also wished that Abraham report on BARC be released.

Discussions

Responding to a query concerning the annual budget of AERB Dr. De answered that the annual budget of AERB was Rs. 30 lakhs, which included 7 lakhs for external consultations, incluuing consultations with health experts. The staff consisted of 30 technicians and scientists, and 11 other staff. He also stressed that the AERB was independent of the DAE, but reported to the Atomic Energy Commission.

When asked whether the AERB conducted surprise visits to nuclear plants to check on operations, workers etc., Dr. De replied that surprise visits were regularly conducted every 2-3 months.

On being questioned as to who would take up the decommissioning and burial of nuclear plants in 2030 A.D.,when their lives would have came to an end, Dr. De passed the question on to Dr. Gopinath.

Asked whether concerned members of the public were included in the the safety committee, Dr. De said that while cognizance was taken of the views of the people , the AERB had not yet considered including individuals from the concerned parties as members in the safety committee.

Referring to the talks of Dr.Gopinath and Dr. Vishnu Kamath, Prof. A.K.N.Reddy remarked that Dr. Gopinath who had access to actual data from the DAE did not present any quantitative data regarding operative safety targets against achieved performance, while Dr. Kamath with access only to public documents was able to present such data. Why this difference of approach? Dr. Gopinath answered that the data were voluminous, and therefore he did not go into details since the time available was limited .

Dr. P.N.Srivastav remarked that Dr. Kamath had referred to the Puckering reactor accident and wished to know if there had been any humans affected or killed. Dr. Kamath replied that he had no information on human deaths, since he had based his "report" on newspaper clippings where no such mention had been made .

Mr. Kumarswamy asked Dr. Gopinath why MAPS got into trouble just three days after it was commissioned despite the elaborate safety measures . The plant soon developed another leak and there was a total loss of energy to the tune of Rs. 40 crores. Dr. Gopinath answered that the possibility of component failure was not ruled out, hence the need for back-up measures. Despite the failure no one was affected. The estimated loss of Rs. 40 crores may not have been entirely accurate. A scientist from the AEC commented that the failure scenarios worked out by Dr. Vishnu Kamath needed further substantiation. For instance the S16 and S15 failures or even S13 and S14 (S16 being complete failure of all back-up) had a probability of less than 10^{-6}, and may even be less than or equal to 10^{-8}. Prof. Dhawan then asked whether such an analysis could be done using available data on Indian nuclear reactors.

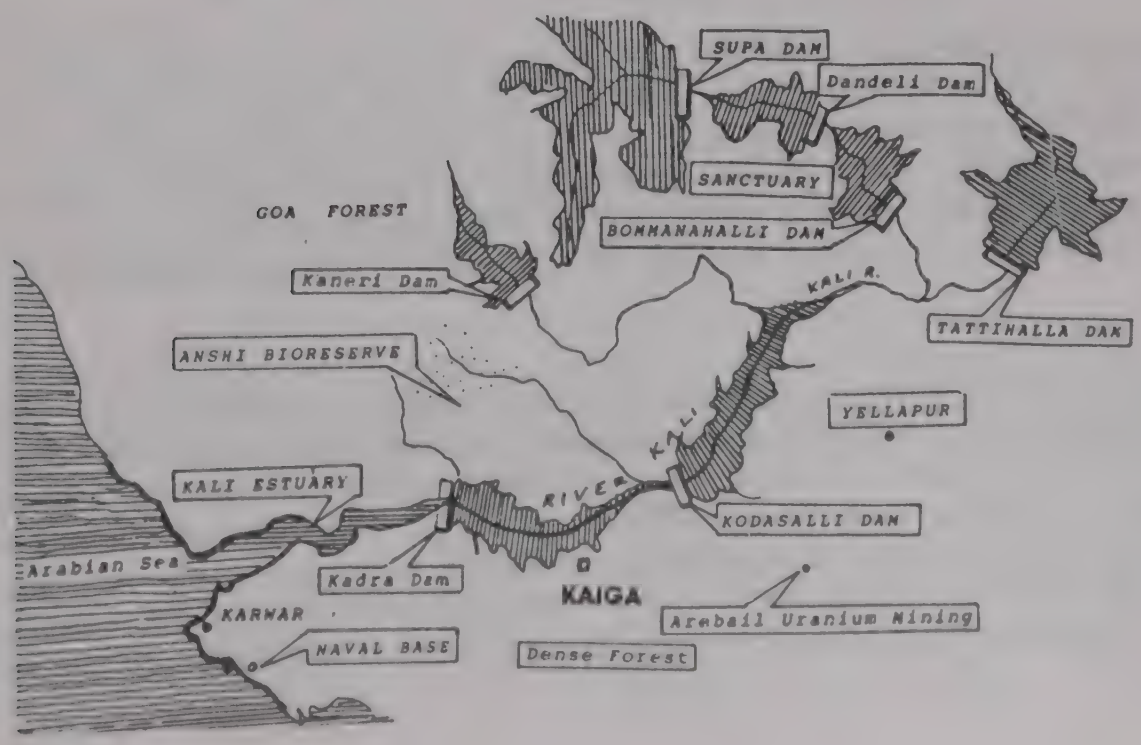
Mr. Nagesh Hedge wished to know whether the AERB could qualify to be called a "regulatory board", if it had no say in site selection. Besides the safety standards defined for Kaiga were inadequate. Dr. De speaking on behalf of the AERB said there are two stages involved in setting up a nuclear power plant. In the first stage, involving site selection, a number of considerations (political considerations included), play a role. The decision was taken by the Prime Minister after having consulted his cabinet. In the second stage, design specifications,etc., were studied by the Design safety Committee, taking local conditions into account. The AERB was called upon to offer its expertise in the second stage.

Dr. L.C.Jain asked Dr. Gopinath that if the waste was not going to be processed and disposed at Kaiga , then where exactly were these operations to be carried out. Dr. M.R. Srinvasan stated that the reprocessing would be carried out elsewhere. The waste from Kalpakam was currently being reprocessed at Tarapur, and no decision had yet been taken to set up a waste reprocessing plant at Kaiga. Since a waste reprocessing plant was being set up at Kalpakam, these operations would be carried out at Kalpakam or Tarapur. Dr. Srinvasan in reply to a question from a participant also said that the policy was not to inform the public when waste was transported.

Dr. Rahul Pandit, asked whether we may suffer a fate similar to that of the Savannah Project. Dr. Srinvasan replied that the incidents refer to military installations which came up during the 1940's and 1950's. These reactors were such that, they would not be licensenced in the 1980's, the safety standards "today" being "totally different".

Dr. V.T. Padmanaban asked whether the AERB had looked into leakage of radioactivity into the environment at the thorium deposits in Kerala? Dr. De replied that many investigations had been carried out at the site on several occasions and the recommendations implemented. Regarding waste in the river, he said that the AERB had not yet been able to look into it.

Mr. G.V.Naik asked whether it was true that in the case of an explosion, the area around the Kaiga plant would have to be evacuated for 30-40 years. Dr. Srinivasan answered that a series of discussions had been held and detailed plans regarding the region to be evacuated in the case of an accident, drawn up. Based on IAEA studies, he said, there was no cause for concern beyond a radius of 1.6 km , but all the same, there were plans for demarcating a 16 km emergency zone for each nuclear power plant . Since radiation was not a prompt killer there was no need for immediate evacuation, for example, in Chernobyl, the decision to undertake evacuation was taken 1-2 days after the accident. He said that in India, for all nuclear power plants, there was a Regional Emergency Committee which included the Chief Secretary of the State and other officials, with whom regular consultations were being held and with whom exercises had been conducted. There was no question of evacuating the region for 20-40 years in case such a contingency arose .



OPEN HOUSE SESSION

Dr.Champa, President of the Karnataka Fishermen's Association said that fishermen would be affected in two ways: (1) river pollution, (2) sea pollution. Both banks of Kali river are inhabited by fishermen who number about 5000. Fishing is their livelihood and this would be drastically affected by the waste water discharge. Tones of oysters would perish. Plankton production would fall because of the effluent that in turn would affect the fish population.

Mr.Manmohan asserted that there was a hydel potential of 7000 MW of which only 12% had been harnessed. Given the cognisance of the problems associated with nuclear power he questioned the rationale of going ahead with such plants.

Dr.Srinivasan said that the DAE had no objection to the prioritisation of hydel energy over nuclear energy. However submergence and rehabilitation made hydel energy more problematic. He cited the instance of Silent valley, Bedthi, Narmada etc. He stressed the need for a 'balanced view' on harnessing energy.

Vishnu Kamat did not agree with Dr.Srinivasan's statements concerning regulations the bizarre US regulations. On the contrary he felt that they were rational, since the licensing procedures are dependent on the local community. There were mechanisms of intervention on account of which the community could call for a public hearing and prevent the licensing of the reactor. He also remarked that the environmental report of Kaiga prepared by DAE did not contain any quantitative information on flora and fauna, nor was this brought out during the discussion in the workshop. He asked for a clarification on whether DAE had conducted such studies and if not, when they wished to initiate the same.

Sanjay Havanur citing the example of the US, said that the entombment of reactor buildings had been ruled out, and the present requirement was to return the area to its original green field status. He further said that the dismantling costs were prohibitively high. A study by NRC-VS had shown that the dismantling costs amount to nearly 15 lakhs rupees per installed MW. However costs of de-commissioning shipping port reactors worked out to Rs.2 crores per installed MW. Commenting on the time factor he said that the burden of decommissioning would eventually be passed on to posterity (22nd century).

Mr.Ramalingam raised the issue of cost-benefit, by comparing the time of service with the time of disuse. He said that Karnataka had a break up of 15 nuclear projects: 6 units at Kaiga, 4 atomic mineral centres at Valakunja, Adakisoma, Brahmasagar, an atomic minerals waste disposal centre at Kolar, atomic mineral deposit centre at Bangalore. Using Westinghouse projections earlier presented by Dr.Shivaji Rao, he opined that in the event of a casualty there will be no safe place to live except the northern most part of Karnataka. He said that REMP at Ratanhalli was planned to produce 5 atom bombs per year.

V.T. Padmanabhan remarked that in 1984, the Chairman of AEC in a conference at Calcutta said that people living in Chavaralu Nagar in Kerala are exposed to 5000milli REM of radiation. Hence they were not exposed to any health hazard. About 20 years ago the Chairman of US AEC said the people of Chavaralu nagar are exposed upto 15000 milli REM. In 1957, the WHO said that there was a need to study this area with respect to radiation effects. He requested the AEC to provide some related figures. In absence of these figures it was necessary to rely on Dr.Kochupillai's figures that suggested that the incidence of Down's syndrome in Chavaralu nagar is three times that in Trivandrum, and 7 times that in Madras.

Dr.Srivastava pointed out that the highest known background radiation in monazite sand areas has been the order of 1200 to 1300 milli REM.

Dr.K.P. George said that the biomedical group at BARC had conducted studies on lower plant systems and observed that there is a correlation between cellulosic abnormalities and background radiation. He said that papers had been published on the relation between radiation and occupational groups, a specific instance of which is the paper published in the Indo- German seminar held in 1983. Giving an overview of the projects being carried out by this group presently he summarised them as follows:

a) An epidemological survey in 18 panchayats
b) A survey focusing on new borns from different hospitals representing various control units and exposed to different radiation levels.
c) Survey for congenital abnormalities like Down's syndrome etc. at birth

Commenting on the occurrence of Mongoloid births he said that an analysis of 32,000 cases had shown the frequency to be one in 2400, 2500. An idea of the frequency distribution of Down's syndrome among child bearing mothers of various age groups are observed to be as follows:

Age group	Frequency
16-20	0.6/thousand
20-25	0.4/thousand
25-30	1.2/thousand

Dr.A.N. Nagaraj said that after the TMI disaster the US government commissioned a study on each reactor to evaluate the extent of damage in the case of serious accidents under different weather conditions. He said that India should conduct a similar study on all nuclear reactors in India before taking up work at Kaiga.

Mr.R.S. Nayak was not convinced about the outcome of the workshop. He wished to know whether DAE would start work on the site after educating and convincing the people. He also desired clarification as to whether there were plans to organise a debate exclusively for local people.

Mr.Murthy made a request for a dialogue on the system in which the nuclear plant has to function. He was of the view that what one needed was well operated and inter connected systems. He further mentioned that this could not be said of any of the power generation systems in the country. Most systems operate at 49HZ frequency instead of standard 50HZ. Consequently, there is a greater sensitivity to small decreases in output, leading frequently to grid collapses. He commented that the AEC is proceeding with its programme without taking note of the system in which it will operate. In the French system, he said that an output of 1000 MW results in a frequency drop of .043 HZ, unlike in India where a drop of 500 MW leads to a drop of 1HZ. He elaborated on the economics operating on reserves. He demanded why the findings of the Sriram Committee on Tarapur and Ramrao Committee on Rajasthan not made public. Dr.M.R. Srinivasan replied that even though it was very difficult to reproduce voluminous reports of this kind, repository centres could be set up at various locations, one such location being the Indian Institute of Science. He further nominated Dr.N.V. Ramanaiah, President of Indian Nuclear Society as the contact person for clarification of doubts, requests for documents etc.

Dr.Chauhan said that human life has accepted industrialization and the associated risks. Responding to Dr.Borgaonkar he clarified that Hiroshima accident was a very unfortunate one. However, it unexpectedly provided an opportunity to fill the information gap which would have otherwise to depend on non-human species.

Dr Gopinath contradicted Mr.Borgaonkar's statement that small is beautiful, by saying that this was acceptable in theory. However, in practice the exploding population pressure was not amenable to such a dictum.

Mrs.A Patel of Bombay Natural History Society asked Dr.Srinivas of AEC'S plans for management of nuclear plants after shutdown and where AEC planned to store the very long half life waste.

Dr.Srinivasan replied that large scale power production reactors have not been decommissioned as yet. However some examples are available. AEC has some experience of decommissioning nuclear reactors such as the first plutonium plant at Bombay. Present thinking is that one removes the spent fuel as well as other highly reactive substances from the core. The priority is to return the area to normalcy, except for the reactor building which has to be entombed. The space occupied by the building is a circle of dia 45 mtr. Provision for decommissioning is made while calculating the economics of such a plant.

Question regarding report of Narain's statement: Mr.Srinivasan said that he did not exactly make the alleged statement. However, in the absence of this knowledge he made a comment as follows: the kaiga report is made up of 3 parts, prepared for the Board of the Nuclear Power Corporation. Beyond this there are lots of other reports which form a part and parcel of setting up any nuclear power plants.

Mr.Kadam pointed out that the Kali dam water containment zone has spread over an area of about 48 sq.miles. The water depth is about 300-400 ft high. A suspected crack in the event of any seismic disturbance may result in a breach of the dam that would possibly submerge the Kali valley for 8 hours upto an average depth of 80 ft. This would affect the Kaiga project. Since the zone demarcating the uranium potential has been identified and the report has been sent to Dept. of Mines & Geology, Nagpur, he wished to know if there were any plans to exploit this potential. Dr.Srinivasan replied that a joint inspection with the KPC had been conducted. Based on this inspection, design and construction would be according to best possible engineering standards. The dam burst scenario and flood routing was considered during the site selection of any nuclear power plant, and accordingly the plinth level designed. Responding to the second question he said that an investigation has been conducted but there are no plans for mining since the process is not economical.

Mrs.Krupa, Member of the team which visited MAPS raised the following points:

1. No worker or member from the public was on the safety committee. When will the DAE introduce members, if it is in its powers to do so?

2. For emergency preparedness everybody in a radius of 16kms should be educated. But nothing of this sort has been done so far.

Dr.Gopinath answered that a safety committee consisted of a group of experts, including health professionals. A Safety committee was not a union activity. Coming to the question of Kalpakkam, he said that a weekly training camp was organised for villagers from different places, wherein they undergo training for about 1/2 a day, during which they are also taken around the complex. Subsequently pamphlets and leaflets are also distributed. Further refresher courses are organised for the district officials who serve as conveyers of information.

Dr.C.S.G. Prasad asked Dr.De whether an independent pool of expertise would cross check the conclusions of DAE? The discussion should be more participative, with the opposite side given credibility

for its views. This particularly applies to the proponents of nuclear energy. Dr.Srinivasan said that the United States Atomic Energy Commission was broken up into USNRE which was subsequently broken into two - ERADA and the another part which was under the Department of Energy. This resulted in fairly bizarre regulations that have meted contradictory treatment to identical nuclear plants. However he fully shared Dr.C.S.G. Prasad's view that more and more people outside the system should be involved in reviewing. He mentioned Prof.De's remark that external experts were being accommodated on the board in order to facilitate the process. He said that the aim should be to get closer to the French system of using national expertise without going in for a legislative divorce between regulatory acts and the need for more energy. Dr.Kochupillai said that in 1976, a report on the effects of chronic low grade radiation in the radiation belt of Kerala was published by his group. At that time BARC was very vociferous about the unscientific nature of the results. The paper was published in Nature which has an international peer review group. Dr.Kochupillai requested Dr.Sundaram, formerly of BARC, to come out with any contradictory material in support of the BARC conclusion. Dr.Sundaram clarified that his opinion was based on the views of many well informed scientists. The findings of Kochupillai were based on the frequency of Down's syndrome occurring in one in 3000 births. However this figure has not been authenticated. Moreover the world average of Down's syndrome is about one in 650-700 which more or less coincides with the observed frequency in the monazite belt. Regarding the research activities of the DAE he said that as he was no longer associated with the department, Dr.George would be in a better position to respond.

Mr.Nagesh Hegde provided an analysis of the radiation affects on various components of the ecosystem. He wished to know whether we have the right to subject these animals to some influence, the consequences of which were unknown. Dr.Srinivasan said that under normal operating conditions the radiation level at the border of the exclusion zone is marginally higher than the background radiation. At this level the impact on the microbiological species will be very small. Discussing the risk elements and the morality involved only resulted in endless dialogue without any concrete steps being taken.

Shri L.C. Jain, Member of Karnataka Economic and Planning Council and Chairman of Expert Group of Perspective Planning of Karnataka, spoke of the decentralisation in order to alleviate poverty. He spoke of the need to look at decentralisation in its fullest perspective, thus doing away with the concept of centralised energy systems. He laid stress on the need for the deliberate accommodation of new energy sources in the plan and voiced his concern as to why the developed world ought to reduce the energy consumption per unit of output.

Prof.Amulya Reddy referred to an Economic Times report of 9th December 1988, on the controversy on spent fuel. Dr.Srinivasan clarified that it would be absurd to say that AEC would be working on a weapon's programme. Plutonium which is a by-product was not weapon grade plutonium.

Prof.Reddy then referred to the Indian Posts report of 9 December, where President Ronald Reagan is said to have signed an executive order that authorises the department of energy to take nuclear material from US commercial power reactors and use them for weapons in the case of a national emergency. Prof.Reddy opined that there is a nexus between nuclear power and nuclear weapon. This nexus involves the intimate, inexorable, inevitable link between nuclear power and nuclear weapons, either directly through the use of power generation as a spring board for weapon production or indirectly through the theft of weapon grade material.

Dr.Srinivasan clarified by saying that in order to upgrade plutonium from high burn up fuel a very complex enrichment process (eg. laser enrichment) is required. He disagreed with Prof.Reddy's opinion regarding the nexus between nuclear power and nuclear weapons. He further said that this was Dr.Reddy's personal opinion and is not based on Indian Government policy.

Mr.Pandurang Hegde raised the issue of safety measures adopted for contract labourers working in the reactor area of nuclear plants. Discussions with villagers living in the proximity of RAPP revealed that whatever little tree cover there was before the plant came up had been lost. He felt that there would be a significant loss of forest at Kaiga due to the firewood consumed by the workers involved in the construction phase of the project.

CONCLUDING SESSION

The first speaker, Mr.J.C. Shah, summarised the proceedings of the first session of the workshop. He said that there seemed to be some areas of agreement and some areas of disagreement amongst the speakers.

The two areas of agreement were, (1) the state of Karnataka needs electricity for its development and (2)that all sources of electrical and non-electrical energy must be utilised and that the need for the conservation of energy must be emphasised. The first of the areas of disagreement was in the realm of energy demand forecasting, which has been a bug-bear of most planners. Secondly, it was felt that while conservation and improvement of energy services is essential, the real barrier lies in convincing users to invest in-conversation measures.

He continued by replying to Prof. Reddy's criticism of the DAE's calculation of nuclear power costs. While concluding, he said that contract labourers employed in the construction of nuclear plants were also protected from the dangers of accidental nuclear radiation exposure.

The next speaker, Dr. Malcolm Adisheshiah, said that he felt that the meeting had fulfilled the purpose for which it had been convened, i.e. a healthy debate between the proponents and opponents of the nuclear option. While this trend needed to be encouraged, the Union Government must be more involved as nuclear energy comes under the purview of the Centre. He laid emphasis on the following points in his speech:-

1) The assumption that the demand for energy is continuously increasing is true only for a particular development scenario and needs to be questioned.

2) He felt that the decision for the commissioning of the Kaiga plant must be postponed for sometime as the issues involved, particularly the effect on the enviroment need to be explored further.

3) There is a need for a neutral regulatory body to look into the information provided by the AEC and incidents relating to nuclear energy.

4) The economies of nuclear power, its health impact and safety record need further study.

5) There is a need to look into the problems of transmuting nuclear waste and disassembly of the nuclear core after decommissioning of the nuclear plant.

6) Nuclear energy must not be used for the production of nuclear weapons.

Dr.P.N. Srivastav said that he was saddened by a lack of an open mind amongst some of the participants of the workshop. He went on to say that while no nuclear reactor was perfectly safe, we were continuously learning of the hazardous effects of nuclear energy on man and the environment by studying the after effects of tragic events like Hiroshima, Nagasaki, Three Mile Island and Chernobyl. The information gathered by these studies would help in the improvement of nculear reactor designs. He also said that it is unfortunate that there is a strong urban bias in our development policy. However, the

members of the Planning Commission have decided that energy-intensive and cost-intensive technologies must not be encouraged. Finally, he said that while there existed an unquestionable need for energy, a choice must be made on the right sources to be exploited.

Prof.Dhirendra Sharma said that the Workshop provided the first oppurtunity wherin the nuclear energy establishment of our country and the opponents of nuclear energy spoke from the same platform. He emphasized the following points in his speech:

1. There is a general lack of available information on the subject of nuclear power.

2. The choice of the site for the Kaiga plant needs to be questioned. The information gathered by the AEC in the course of designing the Kaiga plant needs to be transmitted to the general public as the law does not require that such information be provided.

3. There is also a belief amongst some people that the hazards of nuclear technology far outweigh its utility and hence nuclear technology must not be encouraged.

4. There is a need to explore the use of alternative sources of energy to meet the needs of the people.

5. The developed countries like US, USSR and the EEC have imposed a moratorium on the contruction of nuclear power plants.

6. The people of Karnataka have not been informed of the radiation hazards of Karnataka.

Dr.M.R. Srinivasan began his concluding address by saying that since a large number of people in our country live below the poverty line, there is an increasing demand for energy to improve the standard of living. While there is a need for the use of both renewable sources of energy and fossil fuels, the problems inherent to each of the options necessitate the use of nuclear energy. Hence, by the year 2020 or 2030 A.D., about 30-40% of our energy needs will be met by nuclear energy, which has proved to be a relatively cheap, safe and inexhaustible option. While there is a need to pursue the use of renewable sources of energy and the adoption of alternate social structures, the fact is that, in the current context, there seems to be no choice but to resort to the nuclear energy option. He went on to say that as we live in a sea of radiation, we need not be afraid of nuclear radiation which is comparatively insignificant. He also said that the country's defence policy precluded the use of nuclear waste for the development of nuclear weapons. He countered a few charges made by some of the participants about the nuclear energy programme. In conclusion, he said that if development is to continue, then some risks must be taken. Hence, if we are to generate electricity, we need to pursue nuclear energy.

Mr.R.V. Deshpande, in his conlcuding address, began by saying that this was the first time that both the sides, i.e. the nuclear scientists and the environmentalists, debated the issue in a healthy manner. A larger population has an increased energy demand. While all forms of energy generation entail some damage to our ecosystem of one form or another, the real answer lies in identifying that source of energy such that under local conditions there is a maximal social benefit with minimal social cost. He said that the time had come for removing the veil of secrecy surrounding nuclear energy. All hazardous industries are required by law to inform the people about the hazards encountered in their industries and the disaster management practices they will adopt. Hence, there was no reason why nuclear power plants should not follow suit. In this context, an independent nuclear regulatory body needs to be established. He also said there is a need for the reduction of transmission losses which would result in an increased availability of energy. Finlly the speaker thanked everybody on behalf of the Government of Karnataka for their active participation in the Workshop.

ENVIRONMENTAL IMPACT OF THE NUCLEAR PLANT AT KAIGA

By T. Shivaji Rao

U.S. Supreme Court Judges Douglas and Black described Nuclear Power as "a most deadly, a most dangerous process that man has ever conceived". In fact the radioactive pollutants are a million to billion times more toxic than many chemical poisons. Many experts emphasise that nuclear power proliferation is a serious threat to mankind meriting comparison with nuclear war. But some people believe that it holds the key to national energy and defence problems and is clean, safe and cheap.

However, the former head of U.S. Nuclear Establishment David Lilienthal belatedly admitted in 1981 that "nuclear technology is not really so advanced; it is not dependable enough; it is not safe enough". Even the Russian expert Legasov posed the questions: "Is not the development of nuclear energy on an industrial scale premature? Will it not be fatal to our civilization, to the eco-system of our planet? We must work for the creation of anti-accident centres and centres devoting themselves to compensating for the losses to the environment. The upgrading of the industrial level of safety and the solution of the problem of the relations between man and machine would be a lot more natural thing to do than concentrating the efforts on only one element of the energy structure in the world. This would benefit the whole of humanity".

The Chernobyl disaster actually proved that even a highly disciplined developed nation like Russia could destroy its own human and natural resources and those of other neighbouring nations without a war just by accidental mismanagement of the so- called peaceful uses of the atom.

In the light of the harrowing experiences from Chernobyl disaster most of the countries have decided against nuclear power and some have chosen to close down the existing reactors in a phased program. At this juncture, the Government of India has launched a major expansion program in nuclear power.

Reactors at Kaiga

As a part of this venture it is proposed to establish a nuclear plant (PHWR) at Kaiga in Karnataka with an initial capacity of 2 x 235 MWe and an ultimate capacity of 2000 MWe. In the proposed pressurised heavy water reactors the core is located in a steel vessel known as Calandria that is filled with heavy water and kept at atmospheric pressure. Low pressure heavy water is used as a moderator while high pressure heavy water is used as a coolant, permitting natural uranium as fuel. The fuel rods, separated laterally by spacers consist of natural uranium dioxide pellets clad with Zircaloy. Without reactor shut-down one machine inserts fuel bundle into pressure tube at one end while spent fuel bundle is discharged at the outer end.

As in a pressurised water reactor, the primary circuit of PHWR consists of several loops. For each loop a number of pipes emanating from individual pressure tubes feed into an outlet header that is connected to a steam generator, main coolant pumps and inlet header that again feeds individual pressure tubes. The coolant temperature and void coefficients

are positive. Primary shut-down is provided by vertical absorber rods immersed between the pressure tubes with secondary shut-down, if necessary, by injection of chemicals under pressure into the moderator. Double containment is provided for more safety.

Reactor Safety Problems

Although pressure tube design has positive and negative points from a safety point, the possibility of uncontained fuel melting accidents is not eliminated in this design. Even if pressure tube design precludes the chances of massive pressure vessel failure, the long length, surface area and complexity of the primary system piping results in greater possibilities for loss of coolant accidents.

On-line refuelling provides additional means by which loss of coolant accidents can be initiated. As the pressure tubes are exposed to the full neutron flux, they experience the consequential weakening effects. Due to deuterium-zirconium interactions, delayed hydride cracking occurs in the piping system. Moreover the natural uranium-heavy water void coefficient of reactivity is positive and any loss of coolant accident leads to a power excursion.

A loss of coolant accident coupled with scram failure leads to rapid melting of fuel and possible common mode breach of the containment. While heavy water results in large and hazardous tritium inventories, extensive use of zirconium in the core provides for a large zirconium-system reaction potential. The multi-unit station design may ultimately result in common mode failures which have not been studied in depth in safety analysis in the Indian environment with considerable degree of emphasis on indigenisation on various parts of reactors. Since the containments are not usually designed to withstand some of the worst case accidents involving large scale zirconium-steam reactions, hydrogen and vapour explosions, common mode rupture of primary and secondary coolant systems inside the containment, human failures, sabotage, missile-hits, terrorism, bombing, massive aeroplane crashes etc., it is highly improper to emphasize that nuclear power is absolutely safe.

Safety cannot be engineered in. According to Dr. Hannes Alfen, a Nobel laureate, "although the nuclear experts devote more effort to safety problems than others, the real question is whether their blue-prints will work as expected by them in the real world and not only in their technological paradise".

A number of incidents show that it is impossible to ensure complete safety. A cyclonic storm that hit one of the reactors destroyed five separate emergency power lines, a mathematical impossibility. A research reactor experienced a series of twenty-one sequential failures at the rate of seven failures and three identical channel-systems and surprisingly it was saved by one other system that was not being used because of unreliability. A series of six fatal mistakes made by the Russian experts at their Chernobyl plant proved that even with the best safety systems in the world, no reactor can be considered to be fool proof for all time and that safety ultimately lies in the constant supervision of the safety officers and the undiminished competence of the operators of the nuclear plant.

In fact the Tarapur plant is said to have fuel failure as high as 20% to 35%. Among the prominent failures at Tarapur are the recirculation pumps, control rod drives, electronic monitoring and control systems, instrumentation, cracks in system piping, feed water pumps, leaks in condenser tubes, control valves, steam generator tubes, water lines and extensive corrosion. Because of the defects in design, operation and maintenance, about 350 unusual occurrences are reported to have occurred by 1980 at the Tarapur plant.

Radiation Hazards

With the splitting (fission of the atoms) of the fuel in its core, a nuclear reactor produces abundant heat and many fission products of lighter elements most of which are radioactive. In an additional reaction, atoms heavier than Uranisum such as Plutonium, Americium, Curium and other Trans-Uranic elements that are also radioactive are produced.

The radio-active substances from a nuclear plant can be broadly divided into alpha and beta particles, gamma rays and neutrons. Alpha particles travel for one or two inches in the air. If they get into the human body, they ionise the cells

in organs like nose, eyes and tongue and harm the normal growth of cells. Even the beta particles destroy the cells in various organs of man. When the cells in the blood are thus destroyed, cancer will occur.

The radioactive substances may directly get into man by being inhaled along with the air. The radioactive dust in the air may settle over the land from where it can reach man through the vegetables and fruits. When the grass over such contaminated pastures is eaten by the cattle the pollutants getconcentrated in man through the consumption of milk and meat from such animals. Similarly the radioactive substances that get into the prawns and fishes from the contaminated tanks, rivers and lakes get into man. Thus the radioactive substances gradually build up in man through the consumption of contaminated air, water and food and cause slow but serious damage to different organs in the body even at very low doses! (vide Appendix-I).

Some people may become impotent. The nucleides penetrate the embryo of pregnant women who consequently may deliver deformed babies. Because of their continuous disintegration, the radioactive substances will undergo many changes and ultimately become stable substances. The time taken by such a substance to decay by 50% of its original weight is known as its ''Half life''. The half-lives of some of the pollutants are 5 days for xenon-133; 8 days for Iodine-131; 10 days for Krypton-85; 28 years for strontium-90 and 30 years for cesium-137; 25,000 years for plutonium and crores of years for Uranium-238.

Being chemically similar to calcium, strontium gets into the bones. Similarly caesium like potassium gets into the muscular cells. Unlike the common food substances like sugars, the radio-active substances are not amenable for digestion and hence accumulate in critical organs like gonads, breasts, bone-marrow, lungs and thyroid glands. Administration of 1 to 5 milli-curies of Iodine-131 corresponding to thyroid doses of 1000 to 10,000 rads causes serious damage. The hazards at lower exposure are enhanced by synergy with other common or unusual co-factors (Appendix-II).

Pollution

The radioactive pollutants like iodine and caesium from the Chernobyl disaster of April 26, have created a terror not only in the East European countries but also in other distant places. The dust reached Japan and India as well and contaminated the soil, water, air and food. While the children were kept indoors in Austria, the sale of milk was stopped in Poland. Sweden has prohibited the import of foods from European countries. In some countries they are planning to destroy the cattle and crops exposed to the radiation. People in the productive age group are adopting birth control methods. Some women in their youth are prepared to sacrifice both normal family life and motherhood. The educated youth are agitating that their elders who have kept silent at the time of establishing these nuclear plants have foreclosed their options and their rights for better quality of life to the present population and their progeny.

Annual production of liquid wastes from a 1,000 MW plant is estimated at 4,000 m^3 with low radioactivity of 1 curie/m^3. Similarly the annual discharge of radioactive materials into the atmosphere for a similar reactor are estimated at 12 curies for Tritium and 6 curies for Carbon-14. Discharges from the reactors into the atmosphere may include Argon-41 (from irradiation of air), Krypton-35 (fission product), Xenon-133 and isotopes of Iodine-131 and Carbon-14 from irradiation of reactor materials. From a public health view point, in addition to the above isotopes, Tellurium, Ruthenium and Caesium are also harmful. Exposure of man is due to fission products discharged into the atmosphere. Smaller amounts of radioactive materials (from induced activity in corrosion products etc.) may be discharged with liquid effluents. Pressurized water reactors release mainly Xenon-133, the exposure within 80 Km. being estimated at 0.01 manrems per MW per year.

In the USSR, the emissions of radioactive substances from the Chimney stacks of nuclear power plants per day are limited to 1 million-curie for strontium-90 and strontium-80; 100 millicuries for iodine-131; 500 millicuries for the sum of Beta and Gamma aerosols besides the strontium and Iodine and 3500 curies for the sum of the radioactive inert gaseous isotopes of krypton, xenon and argon. All these substances get into man either through the air he breathes, the water he drinks or the food he eats. Often they get into the food chains and foodwebs in nature, get biologically magnified many

thousandfold and cause slow poisoning effects in man 20 to 30 years subsequent to his first exposure. In the water of Columbia river Zn-65 was found at a concentration of only 25 thousandths of pico-curie (p CI) per gram. Yet local inhabitants contained 4000 PCI in their bodies through bio-magnification.

The hot effluents from the condenser of reactor are bound to have adverse impact on all biological activity, varying from feeding habits and reproductive rates of fish to the changes in the nutrient levels, photo synthesis, Eutrophication, 0_2 - transfer, metabolism and degradation of organic material. Since the summer temperatures of water will be high, this additional thermal input from the condensers may be very harmful to fisheries when the quantities of natural water get diminished during lean periods. The oxygen content will get reduced and the aquatic life will be under great stress. Sometimes the fish, their larvae and eggs will be damaged while passing through pumps and condensers. The chemicals used intermittently for defouling the condensers will adversely affect the fish and the fish-food organisms. The higher temperatures enhance the solution of chemicals and the rate of biochemical reactions and this may prove fatal to different forms of life in the presence of detergents, algicides, corrosion-inhibiters and low-level radioactive wastes discharged along with the condenser coolant.

Kadra dam to be built as part of the Kali Hydro-Electric project will provide 157 TMC of water for cooling purposes by 1990. The condenser cooling waters will be discharged into the reservoir and the Kali river. The thermal pollution will cause serious impact on the fresh water and marine fisheries of the Karwar district. Since the air, water and land resources will be contaminated by radioactive wastes, the drinking water, the agricultural crops, cattle, wild life and human beings will be slowly poisoned. The location of the plant in a seismic region with number of storage reservoirs may lead to many huge catastrophies. The interests of the naval establishment or the Seabird project and Karwar must duly be given the importance for reasons of national security.

The most treacherous aspect of radioactive pollution is that it cannot be detected by physical senses of man such as sight, smell, taste, touch or hearing; that is why any increase in radioactivity beyond the natural background levels is considered harmful to man and international organisations insist on As Low As Reasonably Achievable (ALARA) dose to man. Such low dose of radioactivity is possible only if the reactors are located underground or in rock caverns in islands or coastal areas.

By siting the proposed nuclear plant at Kaiga in close proximity to a major population centre at Karwar Naval base, the nuclear experts are deliberately violating the norms even if public health and environmental safety will be in jeopardy. Even the defence forces and personnel of the "Sea-Bird" project may be adversely affected. The dense and natural forests of the tropics need not be destroyed. In case of power failures the reactors are always provided with alternate sources of energy from a few independent power generators that go into action within a few seconds or minutes. Hence the special facilities of secondary importance such as power-lines, rocky foundations and reservoir storage on Kali river cannot over-ride the crucial aspects of environmental protection in Karwar district and its vicinity.

Socio-economic costs of accidents

According to U.S. and British experts, nuclear accidents will continue to follow the general sequence of Wind-scale, Three-Mile-Island and Chernobyl, the frequency of accidents being once in every 4 or 5 years. Even a partial release of the gaseous and volatile fraction of the core inventory according to a study conducted by Brookhaven National Laboratory in 1956 would produce 3400 deaths, 43,000 injuries and property damage of $7000 million (at 1956 prices) and contamination of land area the size of Maryland. It is said that people will die upto 15 miles and injured upto 45 miles away from the reactor. When this report was revised in 1965, the worst imaginable accident was reported to cause 45,000 deaths, 100,000 injuries and property damage of $17,000 million (at 1965 prices). According to a British study of 1973, the costs of damage due to an accident was estimated at 600 million pounds (at 1973 prices).

After the Three-Mile-Island accident, the US Nuclear Regulatory Commission got a study made by the Sandia National Laboratories on the possible accident sequences for each of the 80 sites with different procedures. For the worst

accident the damage cost was estimated at $314,000 million. The emergency evacuation must be implemented for 10 miles around the reactor and may be extended upto about 50 miles in the sectors down-wind depending upon weather conditions. In the light of the high economic costs for accidents the U.S. Government recently revised the compensation under the Price- Anderson Act to be paid to victims of nuclear accidents to $7000 million from the earliest figure of $560 million. If the lives of Indians are considered to be as important as those of Americans, the Union Government must enact a law similar to the Price-Anderson Act, with financial provision of Rs.10,000 crores to defray the costs of damage due to inevitable accidents in nuclear plants.

Since the State Governments have to save the lives of people and their properties and provide for emergency evacuation, rehabilitation and health care during accidents, they must be prepared to earmark at least Rs.5,000 crores to be kept in deposit with the State Bank for emergency use. The State Govt. should not think that since it gets only ten percent power from the reactors in addition to its normal quota, they cannot undertake the burden of protecting the people and their properties due to accidents in reactors!

According to a recent British study on the socio-economic consequences of a 1100 MWe plant accident at Size-well, people will have to be evacuated upto 140 to 170 kms from the plant under the worst conditions. The costs of damage are estimated at Rs.6,000 crores. If this scenario is extrapolated to the proposed plant at Kaiga, people upto 140 kms must be evacuated within a short-time to distant places (vide Appendix III).

Alternate sites

As practised in some European states, tunnels can be driven in one of the mountains on the Karwar Coast for accomodating the reactors; other infrastructure facilities can be provided on the land, since service-water supply forms 5% to 10% of the project cost, sea-water can be used for condenser cooling as in Madras and Tarapore plants. The low summer storages in the reservoirs on Kali river are bound to exacerbate the radio-active pollution through biological magnification of radio-activity in the food-chains and food-webs of the aquatic eco-systems.

Extensive deforestation will cause siltation of the reservoirs soon. Alternate sites on the islands around Karwar, Basavarajdurg, Muredeswar, Bhatkal and Udupi can be considered if pollution of inland water is to be avoided. Similarly the coastal sites at Gokarn, Bailur, Kumata may be considered for locating the reactors under-ground on the beaches or in the tunnels to be formed in the mountains. Many other sites on the west coast near the mouths of the rivers may be chosen on considerations similar to those followed in selecting the sites for the reactors at Kalpakkam and Tarapore.

Why fresh thinking on siting the reactor at Kaiga?

Dr. Alvin Weinberg, a long time supporter of nuclear power has recently admitted that Rasmassens' famous risk assessment did not take into account the social costs of nuclear accidents. The Chernobyl accident proved that accidents are inevitable; nuclear hazard is somehow different from traffic accidents and the like; the notion of interdicting land with an unseen agent is now viewed by the public as particularly threatening. Dr. Weinberg admitted that it would be claiming too much to insist on the impossibility of an accident that breaches the containment vessel. The chance of a melt-down in a U.S. reactor by 2000 is estimated at one in 12. Can reactors be designed for which the probability of a serious accident is zero (i.e.) a reactor whose safety depends not on the active intervention of safety systems but on the physical principles of its inability to fail? The Uranium fuel is automatically cooled in the inherently safe reactors known as "Modular High Temperature Gas Reactor" (MHTGR) and "Process Inherent Ultimately Safe Reactor" (PIUS). Instead of planning for the conventional reactors, all the experts must concentrate their efforts on developing these reactors as early as possible.

In the meantime, if conventional reactors are to be built, they can be processed only through public support. It must be justly stated that current conditional assurances on reactor safety exclude the possibility of human failure, sabotage, terrorist and enemy attacks. Hence nuclear safety has become a matter of faith. Since the claims of the proponents of nuclear power fail to ensure absolute safety at many plants there is an urgent need for new strategies that provide additional

and that too design-independent margins of safety. Buffer zones provide one of the alternatives. They not only minimise the residual health risks from accidents but also eliminate the danger that a future change in public perception might demand for closure of the reactors on grounds of safety. In selecting alternate sites for the reactors, if people are not taken into confidence the authorities will be simply gambling with public funds and lives of the people yet to be born.

Public Debate needed

In U.S.A. for instance, the decisions on safety aspects of reactor siting are made not on the basis of the enormous costs involved but only from the stand point of protection of public health and environment. In fact, the sponsors of the nuclear plants, in countries like U.S.A. and Japan hold public hearings before finalising the most appropriate site among the different alternates for which environmental impact statements are prepared and circulated among people one month in advance of such a public debate. Unfortunately the Atomic Energy Commission in India plays an apparently self contradictory dual role not only as the promoter of Atomic Energy but also as its regulator and thereby yields to expediency. Hence its views must be taken with a pinch of salt.

In participatory democracy the people for whose benefit the energy is intended must have a say to determine which alternate source of energy or which alternate location for a reactor would be in the best interests of the nation. Intellectuals all over the world argue that what degree of nuclear risk can be tolerated by a society in relation to the alternate sources of energy and alternate locations for reactors is a political decision and such risk assessment is not just a technical matter to be decided by the nuclear scientists alone. Some environmental experts believe that while the application of ecologically sound principles ensures proper siting of the reactor as an asset to society, the wrong siting of the reactor based upon purely economic considerations can often make the reactor a neutron bomb, at least in its damaging consequences during incredible accidents.

Under these circumstances it is incumbent on the people to exercise their right to information and decision-making on the siting of nuclear power plants so that development takes place without destruction of human and natural resources. In the wake of Chernobyl disaster the Prime Minister has demanded for a public debate on the safety problems of nuclear plants. Hence it is necessary that experts and general public discuss about the siting of the proposed nuclear reactor at Kaiga in the State of Karnataka.

Conclusion

Under articles 48(A) and 51(A) of the Constitution on environment both the citizens and the Government have a duty to protect the environment of man. On a complaint from the citizens the Union Ministry of Environment can prohibit the siting of hazardous industries in the ecologically sensitive areas. The site selection committee for nuclear plants might have not prepared the environmental impact analysis reports for making a comparative study of the costs and benefits for different sites. In countries like Japan and U.S.A. such reports are placed before the public for their constructive suggestions before a final decision is taken in the matter by the Government. Unfortunately neither the people nor the concerned environmental experts from the Universities are taken into confidence in India. In the present case, the request of the legislators and the Government for a nuclear power plant in the State and their demand for locating the same at Kaiga on Kali river is not only suicidal but also violates the Constitution. In the absence of statesmen like Sir M. Visweswarayya, people must work as the ears and eyes of the democratic Government so that leaders would not unknowingly pledge the health and welfare of the present and future generations of Kannadigas in a Faustian bargain and that too without holding a public debate on the advantages and disadvantages of nuclear plants and their siting in different places of Karnataka.

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APPENDIX (I)

Myths of safe dose

People are exposed to a background natural radiation of 130 millirems per year. Man-made pollution adds 5 millirems. Exposures due to luminous watches and television screens are each equal to 2 to 3 per cent of the background radiation. Some atomic energy officials feel that exposure of workers to ionising radiation of 5 rems per year will not cause any harm. In the U.S.A. while the Environmental Protection Agency reduced the annual limit of exposure from 500 millirems to 25 millirems for residential zones around the nuclear plants, the Energy Research Agency recommended a limit of only 5 milli-rems for the general public. Environmental scientists holds that as any minute level of radiation produces cancer and irreversible genetic deformities, no dose of radiation is so low that the risk of cancer becomes zero. Unfortunately while the above limits to what is locally released from the plant into the environment are carefully regulated. The cumulative impact of radioactive pollutants from all nuclear activities and the grave consequences of their biological magnification and slow poisoning effects on plants, animal and human populations even in the remote areas are not studied on scientific lines.

APPENDIX II

Some of the Isotopes present in Spent-Fuel

Element	Half-life	Implication
Tritium 3H	12 years	Emits beta rays - absorbed internally
Krypton 85Kr	44 hours	Radiates beta rays - inert gas
Strontium 90Sr	28 years	Emits beta rays - bones, lungs absorb
Iodine 131I	8 days	Emits beta rays - Thyroid absorbs
Xenon 133Xe	5 days	An inert radio-active gas
Cesium 137Ce	30 years	Irradiates body-absorbed internally
Plutonium 239Pu	24,300 years	Hazard to health - body organs absorb

Source: Peat, David, *The Nuclear Book: What happened at Harrisburg? And can it happen here?* (1979) p.47)

APPENDIX III

Places to be evacuated during accident at Kaiga

After thorough scrubbing and decontamination of the lands and equipment due to radioactive pollution from an accident, people can return to their original houses along with their cattle after one year upto 140 Kms, after 5 years upto 115 Kms and after 20 years upto 77 Kms distance from the nuclear plant. Depending upon the weather conditions during the accident, certain areas will be more affected than others. The villages, towns and cities that lie within the zone of influence of an accident in the reactors at Kaiga are marked in the figure. While Karwar, Yellapur, Londa, Honnavar, Kumta and Ankola of Karnataka, Chauri, Quepem and Madgaon of Goa lie within 77 Kms, Bhatkal, Siddapur, Sirsi, Hangal, Mundgod, Kalghatgi, Haliyal, Khanapur, Hubli and Dharwar of Karnataka and Panaji, Ponda, Bicholim and Mapuca of Goa fall within 115 Kms distance from the proposed nuclear plant. While Bainduru, Sagar, Sorab, Haveri, Shiggol, Savanur, Kundgol and Belgaum of Karnataka and Chandgad, Amboli and Savantvadi of Maharashtra lie within 140 Kms, Coondapur, Byadgi, Ranibennur, Shirhatti, Gadag, Nargund, Gokak and other places close-by lie within 170 Kms from Kaiga. Evacuation must be completed within 6 hours for 2 to 5 Kms; 12 hours for 5 to 25 Kms; 24 hours for 25 to 75 Kms and 48 hours for distances beyond 75 Kms from Kaiga, as per the British accident scenario based on a wind speed of 5 m/sec; rainfall of 1 milli-meter per hour and neutral stability conditions.

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Clear-felled forest at Kaiga Site

IS POWER FROM NUCLEAR PLANTS NECESSARY?

IS IT ECONOMICAL?

By Amulya Kumar N. Reddy

The view adopted here is that scientists must dispel ignorance about nuclear power and raise public awareness through debates that clarify the issues and discuss them rigorously. This view differs radically from the recent advice of the Governor of Tamil Nadu that "scientists must dispel misgivings about nuclear power"[1].

Nuclear power programmes generate a number of issues amongst which are the following:

- the hazards associated with the front end of the nuclear fuel cycle, i.e., with the mining of uranium, the extraction of uranium, fabrication of fuel rods, etc.
- the siting of reactors
- the environmental impacts of reactors on human beings, the flora, fauna, atmosphere and water resources in their vicinity
- the safety of reactors
- the handling of emergencies in the event of reactor accidents
- the disposal of low -, medium- and high-level radioactive wastes
- the decommissioning of reactors
- the power-bomb nexus, i.e., the intimate, inexorable and inevitable link between nuclear power and nuclear weapons either directly through the use of power generation as a springboard for weapons production or indirectly through the theft of weapons-grade material.

This presentation, however, will concentrate on two aspects that are not mentioned above:

- is the power that is likely to be generated by nuclear plants necessary for development?
- is that power economical?

Nuclear power is part of the conventional approach to energy planning. In this approach, energy is treated as an end in itself and the focus is on increasing energy consumption. As the Chairman, AEC, said regarding electricity: "...its consumption rate is a prime indicator of the quality of life of the people."[2] The important thing is to make projections of energy demand into the future (invariably assuming that present trends will persist and that business continue as usual).

Such projections often forecast large gaps between demand and supply. Thus, the central question in the conventional approach is how to increase energy supplies in order to bridge the demand-supply gaps. And in this search for supplies, nuclear power which comes in large reactor-size blocs claims a justification.

Let us illustrate this approach with the case of Karnataka where the proposed nuclear plant at Kaiga is to become the subject of a national debate.

A forecast of future demand for electrical energy was made for the state's Economic and Planning Council in September 1983 by the so-called Three-Man Committee.[3] When these forecasts for energy demand were converted into projections for power, it appeared that there would be deficit from the base year of 1982-83 up to the forecasting horizon of 1989-90 and that this deficit would start with a low of 223 MW and end with 593MW.

The appearance of these deficits triggered off the the reflex-like response: "Kaiga, way out of power crunch".[4] In addition, the deficits stimulated demands for a nuclear power plant at Kaiga on the grounds that "There is no other option"[5], "Nuclear power, only hope"[6], "Nuclear power, unavoidable"[7]. But, are these assertions warranted? To explore that question, it is necessary to understand how the Three-Man Committee arrived at its projection.

Various categories of electricity consumers were considered separately. The consumption of the Commercial Lighting, Low-tension and Public Lighting categories was assumed to increase with growth rates of 12%, 11% and 10% per year. The projection for high-tension category was based on the actual demands of the five major power-intensive units (which accounted for 50% of the HT consumption) and the industrial policy of the Government of Karnataka which required a growth of employment-generating industries. The demands of energy on the consumption side were then aggregated and transformed on the basis of assumed values of T & D losses into an energy demand on the generation side. And from this energy demand a projection was made for the requirement of power.

Notwithstanding its sober and rigorous approach, the Three-Man Committee's projection is riddled with assumptions. It is based on at least 16 *explicit* assumptions regarding the growth rates of energy consumption of different categories of consumers. In addition, there are a number of implicit assumptions:

- that the T & D losses will not fall below 20% in 1989-90 (compared to 22% in 1982-83)
- that the conversion of installed capacity into energy availability will not increase to a value greater than 4604 kWh/kW in 1989-90 (compared to the 1982-83 value of 3681 kWh/kW), i.e., the system load factor will improve beyond 52% from the present 42%
- that the energy consumption norms of all categories of consumers will remain at the 1982-83 values, i.e., there will be no improvement in the efficiencies with which various categories of consumers utilize energy.

In fact, the projected demand is very sensitive to changes in some of these assumptions. This means that new options can be generated by departing from the values corresponding to these assumptions. For instance, if there is a weighted average reduction of about 6% in the overall energy consumption norms, the 1989-90 deficit becomes a surplus. Thus, there are options other than the 470 MW of Kaiga (Phase I) for overcoming the apparent deficit.

Some of these other options have been made concrete in the recently submitted Perspective Plan for Karnataka submitted by an expert group appointed by the Government of Karnataka.[8] This Perspective Plan showed that if five conservation measures, viz.,

- modernization (from an energy-efficiency point of view) of Karnataka's power-intensive industries,
- incorporation of frictionless foot-valves and HDPE piping in irrigation pumpsets,
- replacement of inefficient incandescent bulbs with modern compact fluorescent lamps,
- replacement of electric water heaters in homes with solar water heaters, and
- use of LPG instead of electricity for cooking,

has been implemented, the 1986-87 deficit would have become a surplus of 458 MW, i.e., about two Kaiga-type 235 MW reactors. *Thus, there are options other than Kaiga (Phase I) for bridging the demand-supply gap* and the argument for a nuclear power plant for Karnataka is based on a projection that ignores these other options.

The Three-Man Committee's projection for Karnataka is not the most recent. A committee constituted by the Government of Karnataka for preparing a "Long Range Plan for Power Projects in Karnataka 1987-2000 AD" (the so-called SG Ramachandra Committee) submitted a report[9] in May 1987.

Its projection methodology, however, was retrograde compared to the 'rigorous' approach of the earlier Three-Man Committee. In contrast to an actual consumption of 7,554 MU in 1986-87, it argued that the real demand must have been much higher*. In particular, it computed the demand for HT industries from their contract entitlement. This approach led to an estimate of 15,500 MU for the true 1986-87 demand. With this as the base, the SGR Committee simplistically used an overall growth rate of 9% to project the demand into the future. The result is a projection of 47,520 MU for the year

1990-2000 corresponding to an installed capacity of 9,379 MW. In order to achieve this projected demand, the SGR Committee argued for an expansion of Kaiga (Phase I) by an additional 940 MW corresponding to an extra four 235 MW reactors.

But, two serious criticisms of the SGR Committee's methodology have been put forward[10]:

- the use of 100% of the contract entitlement for estimating the true base year demand of HT industries ignores the fact that the consumption was much lower (by as much as 20%) in periods when there was no power cut because there are factors other than power -- the availability of finance, raw materials, labour and markets -- that determine the capacity utilization of an industry.
- the projection does not take into account the possibilities of reducing energy consumption norms through energy conservation by means of efficiency improvements, fuel substitution, etc.

The expert group's Perspective Plan for Karnataka[8] has shown that by implementing the five conservation measures listed above, the 1990-2000 demand can be brought down to a figure as low as 20,126 MU corresponding to an installed capacity of 4,371 MW. *In such a scenario, the case for Kaiga and its expansion by an additional 940 MW disappears.*

Thus, the case for nuclear power depends upon one's attitude towards the demand projections that are used to justify this energy source. If these projections are treated as sacred ''black boxes'', than there is a hesitation to open up the boxes in order to reveal and scrutinize their contents of assumptions -- they are viewed as unalterable destiny offering no other option except that of constructing massive power supplies such as nuclear plants.

When, however, the projections are made 'transparent', it turns out that other scenarios can be constructed. In particular, it is possible --as the expert group's Perspective Plan for Karnataka has done[8]--to develop scenarios based on an integration of conservation and the exploitation of decentralized renewable sources, with conventional centralized sources providing the needful after the above measures. Such an integration has to be based on an evaluation of the economic, environmental and self-reliance implications of conservation, decentralized renewable supplies and conventional centralized supplies. Here, the focus will be on the economic evaluation of nuclear power in comparison with other supply and conservation options.

The Atomic Energy Commission has worked out the costs of nuclear power plants and coal-based thermal power plants.[11] Apart from computing the costs of heavy water and decommissioning in the case of nuclear plants, it has separately calculated the per kWh costs of fuel consumption, operation and maintenance, depreciation and return on capital (including interest during construction and working capital) for both nuclear and pit-head coal plants. When these component costs are added, the unit prices in one of the various calculations are 98.98 paise/kWh for nuclear power and 101.17 paise/kWh for coal-based thermal power (Table 1). Despite this marginal difference, *the AEC proclaimed that nuclear power is cheaper than coal-based electricity* [12,13].

There are, however, several problems with the AEC calculation:

* by treating the heavy water as an input that is leased rather than purchased, a front-end capital cost on which there would have to be a return of 12% becomes a running cost at 8%,
* there are no charges for waste disposal even though such charges are standard practice in nuclear power accounting - Swedish utilities are obliged to set apart 5.30 paise/kWh for this purpose [14],
* no money has been set aside for the handling of emergencies arising from reactor accidents - ''The Chernobyl nuclear disaster and the elimination of its consequences has so far cost the Soviet Union a stupendous eight billion roubles'', i.e., Rs.17,500 crores[15].

When the calculations' are altered to take note of the above points, it turns out that nuclear power may well be costlier than coal (Table 1).

The AEC has also made computations from a modern financial management point of view according to which attention should be paid to both the magnitude and the timing of cash inflows and outflows associated with the investment. In this paper too, advantage will be taken of the modern techniques of discounted cash flow used both in India and abroad for investment planning purposes. These techniques are based on the fact that money nas a time value because Rs. [1/(1+i)^n] = Rs. 0.32 today where i = 12% is the inflation-corrected interest rate, and conversely Rs. 1/- invested today at i = 12% is worth Rs. [(1+i)^n] = Rs. 3.11 after n = 10 years.

The procedure here is to find the ''present'' value (at some reference date, e.g., the commissioning of the plant) of the stream of net costs (i.e., net of benefits) that arise over the lifetime of the project. If to this present value of net costs is added the value of the capital cost (including interest during construction) at the same reference time, then the sum is the *life-cycle* cost of the power plant, i.e., the total of all the costs over the whole life-cycle of the power plant where the costs are discounted at a particular interest or discount rate of 1% to a single point of time.

The life-cycle cost per kW of generation capacity of nuclear and coal-based pit-head thermal power plants has been computed here using the same values as the AEC of parameters such as capital cost, years of construction, capacity factor (i.e., kWh/kW installed), auxiliary power consumption, life of the plant, operation and maintenance expenses, fuel consumption and in the case of the nuclear plants, the inventory and annual make-up of heavy water. Since, however, the results are quite sensitive to the interest (or discount) rate that is used, the life cycle cost per kW has been computed and plotted as a function of the interest rate.

The plots of the life-cycle cost per kW of nuclear and coal based thermal electricity show that *there are two regimes of interest rate - above an interest rate of about 14%, coal is a cheaper source than nuclear power, and below 14%, nuclear power is cheaper than coal-based electricity.* But, the regime that is advantageous to nuclear power shifts to lower values of interest rate

* if AEC's past performance (15 years) is used instead of its present intention (8 years) for the construction time of a nuclear plant,

* if waste disposal costs are incorporated into the costing as is standard practice in many OECD countries,

* if the Comptroller and Auditor General's estimate[16] of Rs.13,800/kg is used for heavy water costs instead of the AEC's value of Rs.7,200/kg.

It is clear, therefore, that *AEC's conclusion that nuclear power is cheaper than coal based electricity is the fortuitous result of neglecting waste disposal costs and choosing favourable values for several parameters particularly plant construction time and heavy water cost.*

When the life cycle cost per kW of hydroelectric power plants are also plotted against interest rate, it turns out that they are always lower than both nuclear and coal-based thermal power plants.

What have been considered thus far are nuclear, coal-based thermal and hydroelectric power plants. If the search is not merely for least cost *centralized* plants, but at least cost supplies, then the decentralized supply options (small hydroelectric, biogas and producer gas plants, etc.) must also be considered.

In the matter of energy, however, the true indicator of development is the level of energy services provided - cooking, lighting, heating, stationary and motive power - and not the magnitude of energy used. For, it is the level of services provided by energy that determines the quality of life and the extent to which basic needs are being satisfied. Energy services, in turn, depend upon end-use devices (stoves, lamps, furnaces, motors, engines, etc.) to convert energy inputs into the *useful energy* required to provide energy services. Useful energy is simply given by the product of the efficiency of the end-use device and the energy input:

Useful Energy = Efficiency of end-use device x Energy input

The goal of development requires a sustainable increase in the level of energy services and there are four options for achieving such increases:

Option 1: Increasing the magnitude of the energy inputs through increased supplies from conventional centralized sources (hydroelectric, coal and nuclear power plants) and keeping the efficiencies of the end-use devices at present levels.

Option 2: Increasing the magnitude of the energy inputs through increased supplies from non-conventional decentralized sources (mini- and micro- hydroelectric, biogas and producer power plants, etc.) and keeping the efficiencies of the end-use devices at present levels.

Option 3: Increasing the efficiencies of the end-use devices and keeping the magnitude of energy inputs constant.

Option 4: Increasing both the efficiencies of the end-use devices as well as the magnitude of the energy inputs through improvement of present supplies, development of renewable sources and increase conventional supplies.

The conventional approach to energy restricts itself to *Option 1 with its exclusive emphasis on centralized supplies* of hydro-electric, coal-based and nuclear electricity. However, the centralized supply options are becoming increasingly unaffordable because their marginal costs are continuously increasing - it is more expensive to produce the next kilowatt than the previous one! Their environmental impacts are also escalating. Precisely at a time when the populace is rising in protest against their environment degradation, they are demanding impossibly large investments.

To counter the environmental degradation of the centralized supplies, *Option 2 has an exclusive emphasis on renewable sources.* But, this option is only an environmentally benign version of Option 1 - it is just as supply-biased. *Option 3 has an exclusive emphasis on conservation.*

Option 4 is the new paradigm for energy planning. It involves a rejection of all the three extreme positions represented by Options 1, 2 and 3. The new approach insists on a consideration of whether supply increases or efficiency improvements are more effective from the point of view of economics, environment, self-reliance, etc. In other words, the question must be asked whether it is cheaper, more environmentally benign and more conducive to self-reliance to save a kilowatt or generate a kilowatt.

Thus, our universe of consideration must extend beyond the *generation* options to allow for the fact that the same level of energy services can be achieved either by generating a kilowatt or by saving a kilowatt. With this motivation, the life-cycle costs per kW saved have been computed for three of the specific conservation measures considered by the expert group's Perspective Plan for Karnataka:

* replacing electric water heaters in homes with solar water heaters,
* replacement of inefficient incandescent bulbs with modern compact fluorescent lamps,
* incorporation of frictionless foot-valves and HDPE piping in irrigation pumpsets.

The savings for all these measures takes place at the *consumption* end of the electricity system, and therefore must be adjusted for the T & D losses and the capacity factor to make comparisons on the same footing as generation. In Karnataka, saving kilowatt on the consumption side is equivalent to generating 2.03 kW.

The life-cycle costs per kW saved through compact fluorescent lamps, solar water heaters and frictionless foot-valves and HDPE piping can now be compared with the plots of life-cycle costs per kW generated for nuclear, coal-based and hydro electricity. This comparison leads to four important conclusions:

* Saving is associated with much lower life-cycle costs than generation - this result is in agreement with the experience accumulating in many countries (both industrialized and developing) that conservation alternatives are one-

third to one-half cheaper than the centralized options. (Incidentally, conservation is also *quicker* and more environmentally benign.)

* The generation curves rise with interest rate because the impact of the larger front-end capital costs of generation projects increases with interest rate. In contrast, the conservation curves fall with interest rate. This difference is because the small doses of capital investments are spread out over time and therefore the farther into the future these investments are made, the smaller are their present values.

* The difference between generation and conservation life-cycle costs increases with interest rate. This means that the less the availability of capital, the more should conservation be preferred, and therefore, in capital-starved countries, there should be a greater emphasis on conservation.

* Among the various centralized supply options, it appears that nuclear power has the largest life-cycle costs - this result too is in accordance with the findings in UK and USA.

It is also possible to compare the cost (in paise/kWh) of saving or generating energy. The comparison shows that even if the projections and scenarios indicate large demand-supply gaps in the future, *the most uneconomical way of bridging these gaps is through nuclear power plants.* Hence, if the principle of least cost planning is adopted, then the consideration of options for bridging the demand-supply gap should take place in the following sequence:

conservation - decentralized renewable sources - hydroelectric plants - coal-based pit-head power plants - nuclear plants.

Of course, economics alone cannot be the sole criterion of choice of options. it is also necessary to consider environmental impacts. When this is done, it turns out that these environmental impacts can be considered to increase in the following order:

conservation - decentralized/renewable sources - centralized sources (hydroelectric/coal-based thermal/nuclear plants).

The main difference between the ranking of environmental impacts and of economic costs is that it is not easy to provide a relative ranking of the environmental impacts of the centralized sources though the relative ranking of their economic costs can be ranked reasonably unambiguously.

Strictly speaking, the costs of improving the efficiency of current supplies, i.e., efficiency improvement (conservation) on the generation side, should also be included in the sequence. Assuming that these costs will come between conservation and decentralized renewable sources, it is suggested that the demand-supply matching process should be carried out as follows:

* determine how much of the unmet demand can be satisfied with least-cost conservation measure on the consumption side and with improvements of the efficiencies of the present supplies
* deploy decentralized renewables to meet as much of the remaining demand as possible,
* if there is still unmet demand, consider macro-hydroelectric, coal-based thermal and nuclear plants in that order.

If opportunities for efficiency improvements are systematically identified and exploited wherever cost-effective, the magnitude of energy demand can come down sharply. In this context, energy supplies need not become a constraint on growth. As Gandhiji said: "The world has enough for every man's need, but not enough for everyone's creed!" Above all, it appears that our energy future is more a matter of choice than of destiny.

The above sequence in which saving/generation should be placed on the agenda for discussion is the economic rationale for the viewpoint: "Nuclear power should be the energy source of the last resort!" adopted in the book ENERGY FOR A SUSTAINABLE WORLD[17].

If this approach is followed, nuclear power may or may not find a place on the agenda depending on the actual magnitudes of demand, saving and supplies. In the case of Karnataka, the numbers seem to indicate that there is no case

for Kaiga (Phase I) or for the expansion of Kaiga (Phase II). But, for other states and for the country at large, energy analysts have much research to do. Hopefully, they will follow the sequence:

Analysis - Advocacy - Action

It is also hoped that academics and academies will encourage the scientific enquiry required for the analysis.

This analysis may stimulate the nuclear establishment to alter their belief that "Nuclear power should be the energy source of the first resort!" and reverse the sequence that they have followed thus far:

Action - Advocacy - Analysis

In conclusion, it is gratifying to note that the Indian Academy of Sciences has shown the concern and the courage to discuss a matter of immense public interest. If it continues in this vein, it will carve out for itself a place in history as its founder was ensuring during its first few decades.

NOTES

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Table 1 a:

Parameters used to calculate unit energy costs of electricity generated from coal-based pit-head thermal power plants and nuclear power plants.

PARAMETER	UNITS	NUCLEAR	COAL
Installed capacity	MW	2 x 235	2 x 210
Capital cost	Rs crores	724	621
Capital cost	Rs/kW	15,404	15,786
Construction	years	8	8
Year of commissioning		1992	1992
Capacity factor	kWh/KW	5,500	5,500
Auxiliary consumption	%	10	10
Net energy per annum	10^6 kWh	2,326	2,079
Economic life	years	25	25
Depreciation	%	St. line	3.6
Operation & maintenance	Rs crores	10.30	14.00
Working capital	Rs crores	38.70	30.00
Return on capital	%	12	12
Fuel consumption			
Uranium	g/kWh (net)	0.024	
Coal	kg/KWh (gross)		0.532
Oil	ml.kWh (gross)		
Fuel cost			12
Uranium	Rs/kg	4,520	
Coal	Rs.tonne		577
Oil	Rs/kilolitre		3869
Heavy water			
Inventory	tonnes/reactor	250	
Lease rate	% per annum	8	
Make-up	tonnes/reactor	8	
Price	Rs	7,220/kg	
Decommissioning cost	Rs/kWe (1983)	1,000	

Table 1 (b):

Comparison of unit energy costs (in paise/kWh) of electricity generated from coal-based pit-head thermal power plants and nuclear power plants.

	Cost Item	Coal	Nuclear	
			AEC	Corrected
1	Fuel consumption	39.27	10.95	10.95
2	Heavy water pool	n.a.	12.42	n.a.
3	Heavy water make-up	n.a.	4.97	4.97
4	Operation & maintenance	6.73	4.43	4.43
5	Decommissioning & waste management	-	1.10	5.00
6	Accidents/emergencies	-	-	-
7	Depreciation	12.33	14.59	21.88
8	Return on capital	42.84	50.62	74.93
	Total	101.17	98.98	122.06

Stop Kaiga Movement (SKM)

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Press Note - For Favour of publication

The Nuclear Power Corporation is planning to build at Kaiga in Karwar, barely 20 kms from the Goa border an atomic power station with two nuclear reactors of 235 mw each, with four more to follow. If any mishap occurs at this atomic power station, the entire State of Goa will be wiped out. And this project must therefore be stopped, with all urgency.

In setting up this project, the Department of Atomic Energy has contravened its own criteria in site selection:

1. Kaiga receives very high rainfall, more than 3000mm per year.
2. Wind velocity at Kaiga goes beyond 100kms per hour.
3. Solar ponds to evaporate low level nuclear wastes are not feasible in this area.
4. During an emergency the area gets isolated, rendering evacuation impossible.
5. The site falls within seismic zone III, close to the boundary of zone II, as per the revised Seismic zoning map of India.
6. A primary deep seated northwestern-southeastern fault, which runs from Cauvery basin upto Ratnagiri, lies just about 70 kms northeast of Kaiga, as shown in the ONGC (Oil and Natural Gas Commission tectonic map of India).
7. Another NE-SW trending fault, which runs upto Tungabhadra dam and curves down towards Nagarjuna Sagar, is only 60 kms southwest of Kaiga, as discovered by the Geological Survey of India.
8. There are four more faults that lie within 25 to 115 kms of the Kaiga plant site.
9. There are several clusters of epicentres close to Kaiga, with magnitudes going upto 5 on the Richter scale.

In the district of North Kanara, where already the forest cover stands reduced from 80 to 30 per cent, Kaiga will cause substantial further ecological damage, particularly through destruction of rain forests.

Worse still, to have such a major atomic power station right next to the Seabird project, the largest naval base in India, makes the possibility of a major disaster very real.

In case of mishap, people within a radius of 140 kms must be evacuated within a very short time. This radius includes the whole of Goa. In Indian conditions evacuation within the time available is just not possible. The prospect is ominous.

We demand that all work on the Kaiga Atomic power project be stopped forthwith.

A similar proposal for setting up another atomic power station at Jaitapur, Sindhudurg, which will pose equal threat, is being considered, and we equally demand that this be stopped.

We insist that the Government of India arrest the senseless effort of the DAE and The Nuclear Power Corporation at atomic empire building regardless of the potential threat to life of millions of citizens, and destruction of natural resources which took life-times to build up.

We remind the GOI that in the wake of the Chernobyl disaster the people of Sweden in a referendum decided to phase out all nuclear power by the year 2010. In Austria a referendum banned the start of the already completed Zwentendorf plant. The PNPP reactor in Bataan, Philipines has been mothballed by the Aquino Government. The Soviet Union has

abandoned the Krasnodar power plant, near Minsk. And no nuclear reactor has been ordered in the USA since 1976.

We demand that the Goa Government should do its duty and join the people of Goa in demanding an immediate stop to the Kaiga project, and the Jaitapur proposal. And that it should immediately obtain, officially, details of the threats posed by Kaiga project, and make full public disclosure of them.

We demand that the Government of India stop all work at Kaiga forthwith, and abandon the Jaitapur proposal. And issue a public assurance that these projects will not be pursued without a public referendum, since the threat is to our entire State.

We the undersigned found the STOP KAIGA MOVEMENT (SKM), resolved to STOP the establishment of the Kaiga Nuclear Complex, and the proposed Jaitapur plant, before the entire population of the West Coast, in Goa, Karnataka and Maharashtra is placed at most serious and unwarranted risk.

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THE OGRE NEXT DOOR

By Claude Alvares

Allowing the Zuari Agro Chemicals fertilizer factory at Sancoale was bad enough. That unit arose in addition to Hindustan-Geigy's hazardous pesticide production plant at Corlim. Now the Thapar group has commenced construction of its Nylon-66 project at Ponda and with the Janata Dal in command at the Centre, Mukund's Viren Shah is attempting to put up a gigantic steel plant at Bicholim. Power Minister Zuwarkar for some reason only he is convinced of insists that Goa should have a Thermal Power Plant.

In addition to these huge projects, all proposing gross environmental penalties, is the ogre emerging next door, across the western ghats, a bare 22 kms from our southern borders: the Nuclear Reactor Complex at Kaiga.

The nuclear reactors proposed at Kaiga do not involve just environmental penalties: they threaten ordinary survival as well. Once, and if, these reactors are commissioned, life in Goa will come under a state of radioactive siege, for as long a time into the future as we can imagine.

Monsoon clouds are restricted to four months in the year: they also bring water and life.

In contrast, Goa will now have to cower under a permanent cloud of anxiety that will (unlike the monsoons) never fail. That is reason enough to pause and ask what the hell's going on 22 kilometres outside this state of ours.

People all over the globe, except if they are directly employed by the nuclear industry or in nuclear oriented multinationals, are more than adequately convinced that nuclear power and nuclear reactors are a form of technology that mankind is better off without, and ought to learn to do without. Many degrees worse than the plague. After the devastation caused by a series of nuclear accidents culminating in the well known Chernobyl nuclear disaster, the human race can no longer pretend that it has not been properly cautioned about the chilling dangers this form of energy production involves.

What do nuclear reactors do?

Like dams and coal-based thermal plants, they produce electricity. The splitting of uranium atoms in the core of the reactor through the fission process generates enormous quantities of heat. This heat is used to boil ordinary water and produce steam, which in turn is used to drive turbines to make electricity.

Every nuclear reactor designed in India has the capacity to produce 235 MWs of electricity. The Nuclear Power Corporation, the body set up recently to take over and run all Indian reactors, originally intended to install just two 235 MW capacity units at Kaiga. Now the corporation has decided to increase the number of reactors from two to six. In other words, the Kaiga complex will host a generating capacity of 1410 MWs of power.

All of this power is destined for the Karnataka electricity grid. Since Goa meets its power requirements partly from Karnataka, one could argue that our state may stand to benefit from any increases in power made available in the region. However, no one that I know has as yet claimed that the Kaiga based reactors are necessary for supplying electricity to Goa. The basic idea is to supply the power to important industrial and urban centres like Bangalore.

What are the problems associated with nuclear plants?

First, during normal operation, such plants discharge varying quantities of life-threatening radioactive substances into the air. In the case of the Kaiga site reactors, these emissions can be expected to move upwards into the ghats and get deposited in forest, grasslands and other areas. From here, the radioactive substances would get into the Goa watersheds and later the food chain, damaging people. They would also get deposited through rain clouds and rain in the general Goan environment.

The fact that people in the vicinity of reactors suffer cancers far above those who do not indicates that radiation from the plants is often uncontrolled and is life threatening.

But the other major problem with nuclear reactors is the very real possibilities of their undergoing an accident. Even those who manage them acknowledge the fact that reactors are extremely complex and inherently dangerous. No doubt engineers design elaborate safety systems, and other systems to back these up. But nothing is perfect. Either the operators or the technology fails. Accidents are quite frequent and in England alone, average ten serious ones per year.

Should any one of the nuclear reactors at Kaiga go out of control (which is entirely conceivable) and a "meltdown" or an "explosion" occur, this would lead to the release of vast quantities of radioactive elements and gases into the atmosphere. Radiation of course kills.

Now nuclear disasters are infinitely worse than industrial disasters. In the world's worst industrial disaster at Union Carbide's Bhopal plant, for instance, more than 3,000 people were killed and thousands of others injured. Some of these victims now suffer from severe disabilities because the deadly chemical (methyl isocyanate or MIC) that was released from the factory over the city, entered the bloodstream of the victims altering its chemistry.

Without in any way minimising the enormity of that disaster, one should still argue that after the gas had dissipated and become neutralized, people could return to the area. No one yet knows the biological damage caused by the MIC to the soil and to the fauna of the area. Something shocking may indeed emerge. For instance, recent studies have shown that extremely toxic chemicals have leached into the underground water supply of the entire area in which the UC factory is located.

However, compare the consequences of the Bhopal disaster with the consequences of a nuclear disaster at Kaiga. There is really no need to be speculative or even dramatic about what would happen if such an accident were indeed to take place.

Shivaji Rao, Professor of Environmental Engineering at Andhra University, recently made a detailed list of the areas that would have to be evacuated in the event of an accident at Kaiga.

He wrote:

"Evacuation must be completed within 6 hours for an area 2 to 5 km. around the reactor; 12 hours for an area 5 to 25 kms; 24 hours for an area 25 to 75 kms and 48 hours for distances beyond 75 kms from Kaiga, as per the British accident scenario based on a wind speed of 5m/sec, rain fall of 1 millimetre per hour and neutral stability conditions.

"Depending upon the weather conditions during the accident, certain areas will be more affected than others. While Karwar, Yellapur, Londa, Honavar, Kumta and Ankola of Karnataka, Chauri, Quepem and Madgaon of Goa lie within 77 kms, Bhatkal, Siddapur, Sirsi, Hangal, Mundgod, Kalghatgi, Halliyal, Khanapur, Hubli and Dharwar of Karnataka and Panaji, Ponda Bicholim and Mapusa of Goa fall within 115 km distance from the proposed nuclear plant."

According to Prof. Rao's scenario, the population of the entire state of Goa would have to be evacuated within 48 hours.

How such an evacuation of 15,000,000 people is to take place in such a short time is not certain. It is not even known whether it is feasible. Certainly the NPC has no such emergency evacuation plan available. At the moment the NPC is refusing to draw up such a plan simply because the very exercise might induce legitimate fears in the Goan population at large. However, even conceding that a 48 hour emergency evacuation is possible, the next question one asks is: when can the Goencar return to his castle?

"After thorough scrubbing and decontamination of the lands and equipment due to radioactive pollution from an accident, people can return to their original homes along with their cattle after one year upto 140 kms, after five years upto 114 kms and after 20 years upto 77 kms distance from the nuclear plant."

This means that the whole of Goa will have to remain uninhabited for a period of five years: the area upto Margao will remain out of bounds for human beings for more than 20 years.

Prof. Rao addressed a letter to Chief Minister Rane in December 1988, in which he called his attention to the potential risks to the state of Goa as a result of any nuclear accident at Kaiga.

"Radioactive pollution", he noted, "does not respect political boundaries."

The globe learnt the truth of this simple statement during the Chernobyl nuclear disaster in the Soviet Union on 26th April, 1986, when radioactive substances from the reactor based in Russia invaded Europe and the United States.

The Chernobyl disaster was only one of several disasters that have occurred with nuclear plants simply because the technology itself is extremely hazardous and difficult to keep under control. Control systems can fail. There can be no fail safe control system.

The scale of the nuclear disasters, especially of the four major ones that have taken place, is astonishing. If any such equivalent event took place at Kaiga, the consequences for Goa in the light of what has happened elsewhere are totally unimaginable and also totally unacceptable.

The first major nuclear disaster was the September 1957 accident at a radioactive waste dump near the town of Kasli in the Southern Urals in the Soviet Union.

The explosion of a tank filled with radioactive waste created a radioactive cloud 105 kms. long and 9 kms. wide, and required the immediate evacuation of 10,000 people (18 months later, the figure had reached 101,000) from the area. (In comparison, the radioactive cloud formed by the Chernobyl explosion was 25 times larger).

The ground area most severely affected at Kasli was 300 kms. long and 8 to 9 kms. wide. (Incidentally, this is exactly the geographical spread of the state of Goa in relation to the proposed Kaiga reactors). Even today, about 20% of the area in the Southern Urals is still not fit for human habitation.

In 1960, Professor Lev Tumerman, a former head of the biophysics laboratory at the Institute of Molecular Biology in Moscow, visited the area, He described it thus:

"As far as I could see was empty land. The land was dead - no villages, no towns, only chimneys of destroyed homes, no cultivated fields or pastures, no herds, no people - nothing. It was like the moon for many hundreds of square kilometres, useless and unproductive for a very long time, maybe hundreds of years."

All the villages and small towns in the area had actually been destroyed by the authorities to prevent people from returning. A decade later, doctors were still persuading pregnant women to undergo abortions.

No news about this disaster was ever given to the public or to the International Atomic Energy Commission (IAEC) at Geneva. The American CIA came to know of the disaster but did not disclose details to the American press because

it feared it would lead to a backlash against nuclear power development in the United States. The first full report on the (1957) disaster was given to the IAEC by the Soviet Union only in July 1989!

Barely a month later in another part of the globe, another nuclear accident occurred, this time in Windscale, England.

In October 1957, the Windscale nuclear plant was producing plutonium for military use. A fire broke out at one of the atomic piles (the piles contained uranium which was irradiated to produce plutonium) and it raged for 16 hours.

The radioactive cloud that was released from the plant during the fire contaminated large areas of Britain and Ireland, and contained 600 times as much radioactive iodine as was released during the (1979) Three Mile Island nuclear accident in the United States.

All that the authorities in England did at the time was to destroy two million litres of milk that had got contaminated. Though the fire broke out on October 7, 1957, farmers were not informed about it till October 13, that too after the worst of the cloud of radioactivity had already passed over the country. Milk with contamination levels upto three times the official (safe) standard continued to be released for consumption.

The then England Prime Minister, Harold Macmillan, ordered all information about the accident to be kept secret. Authorities also decided not to evacuate the local people even though the latter had been exposed in a matter of hours to radiation levels 10 times the permissible lifetime dose. When one of the scien- tists at Windscale, Frank Leslie, wrote a letter to the Man-chester Guardian criticising the Atomic Energy Agency for not warning people to remain indoors, Macmillan's response was: "Dr. Leslie must be an opinionated ass."

It is estimated that more than 1000 people developed fatal cancers as a result of the contamination. A good number of victims included children. In 1989, more than thirty years later, a British court passed an order permitting the families of 18 children suffering from leukemia (linked to the fire) to sue British Nuclear Fuels, the organization responsible for the reactor.

The true nature of the Windscale disaster was not revealed to the public till 1987, thirty years later, when the documents concerning the disaster, under English law, became public. The British Government in fact, has decided that evidence of individual witnesses to the committee of inquiry into the fire is to be kept secret for a further 20 years.

The disclosures on Windscale (the name was later changed to Sellafield) led a Green Party spokesperson from Sweden to state: "The accident shows not only that nuclear power is the biggest threat to the environment, but that it is also a major cause for the failure of democracy."

The third major disaster was the Three Mile Island 1979 accident in the United States.

At TMI, a series of mishaps led to a malfunction in the cooling system: a pump driving water to a steam generator quit operations, setting in rapid motion a bewildering sequence of events that ended in a partial meltdown of the core. One of the consequences was the creation of a huge bubble of hydrogen 1000 cubic feet in size, within the reactor.

Had the bubble expanded further or exploded, a full meltdown of the core would have been inevitable, leading to what has been called in the literature as the "China Syndrome": the hot molten mass would be so furiously hot and intense it would bore into the ground and come out the other side of the earth. Eventually, after a number of terrifying days the bubble reduced in size of its own accord. Scientists heaved a sigh of relief. The situation had long since gone out of their hands.

During the crisis, the Harrisburg township adjoining the stricken reactor was given the option of staying on or moving out at the utility's request. Such is the confidence of people in nuclear engineers, that the population gladly moved out!

The clean up of the plant was supposed to be completed within three years, by 1982, at a cost of US$300 million to US$400 million. Today, with US$1 billion already spent, the work is nowhere complete.

And then there was Chernobyl.

A few months before Chernobyl exploded (April 26, 1986), Mr. Raja Ramanna, then chief of India's atomic energy programme (and also its most notorious defender) was telling anti-nuclear agitators in Bangalore that it was as impossible for a nuclear reactor to explode as it was for a man jumping out of a window to fall upwards to the sky.

After the explosion had shattered the credibility of nuclear experts and authorities all across the planet, India's nuclear barons began an elaborate attempt to prove that Indian reactors were anyway different from Soviet reactors! Even while such statements were being made, the Indian Government was busy signing agreements with the Soviet Union to install two 1000 MW nuclear reactors at Koodangulam in Tamilnadu!

The destructive and deadly impact of the Chernobyl reactor fall-out may never be completely known for decades. The Soviets today estimate the final cleanup may well cost them upwards of 200 billion roubles.

Agricultural land in the vicinity of the exploded reactor is a total loss for two complete generations.

The radioactive plume that emerged from the devastated reactor contaminated large parts of the Soviet Union, then invaded Europe and next the United States. India was also affected in quite a dramatic way: radioactivity-contaminated butter was exported to the country from Europe as part of the Operation Flood milk programme. Who knows, some of that butter might even have reached Goan consumers. The Ponda dairy sells reconstituted milk consisting of imported butter, milk powder and water.

The fallout of the disaster within the USSR is still enormous.

The direct impact was itself quite severe. More than 250 people died immediately or in the near aftermath. Of the 4,000 workers at Unit 4 (which exploded), 85% have already been retired because of ill health.

At Priapat, soil has been removed three times over and new concrete paths installed. All trees and other vegetation have been removed. Yet radioactivity is still impossibly high.

Eleven areas with 17 million inhabitants are affected by the disaster today and about one quarter of Byelorussia. 420 villages ought to have been immediately evacuated. In the early days of the accident, one of several clouds of cesium and strontium was seen moving across Byelorussia towards Moscow. The cloud was dispersed towards Mogilev using aircraft. As a result more than 100,000 people (including 10,000 children) are said to have fallen sick.

A map of the affected areas was only published in 1989!

In the Chernobyl zone, 1 million have suffered genetic damage, and more than 3000 fallen seriously ill. Of 1,000 pregnant women, only 65 have had successful labour. Out of these only 37 children have survived. Some are born without eyes, ears or limbs.

Overall the disaster necessitated 640,000 evacuees, 215,000 of them children. By 1990, four years after the disaster, the authorities decided another 100,000 would have to be evacuated because of continuing radioactive contamination of land.

In the beginning the authorities pretended that the impact was not going to be as serious as everyone had feared. But now the manifestations are there for all to see. Nobody can deny them any longer. Chernobyl is turning out into the worst possible disaster man has ever known.

On 3 March 1990, the government of the Ukraine announced that the three operating reactors at the Chernobyl Atomic Energy Station will be phased out of operation in the next five years. It would also halt all further construction of nuclear reactors in the Ukraine.

It is important to note that all these four major nuclear disasters occurred due to different reasons. This is to be expected, since in any event no nuclear engineer can prepare for every possible accident scenario. All four disasters also took place in the so-called advanced countries which have a longer and more intensive experience with nuclear power than we in India do.

Besides the real possibilities of an accident involving the reactors within, there are in the case of the reactors at Kaiga additional possibilities of accidents from without. The nuclear reactors proposed at Kaiga are going to be within 50 kms. of Seabird, the largest naval base being constructed in India by the Indian Navy. During a war, the reactors would become the target of attacks and thus endanger the maintainability of the naval base as well.

The Kaiga site is downstream of six large dams. If any one of them fails, all the reactors would be in serious trouble.

The impounding of massive quantities of water behind the six dams is also bound to induce tremors and earthquakes and these would naturally damage the reactors.

All these disturbing questions concerning the Kaiga based reactors have provoked nothing less than a major outcry against the proposed reactor programme from the public in Karnataka. The protest has been so sustained and effective that the Karnataka Government has been forced to try and take the public into confidence about the nuclear plants. Numerous debates and discussions have been held between nuclear scientists and villagers.

In fact, the Karnataka Government has done a great deal to try and reassure the public's fears. For instance, it invited teams of anti-nuclear activists to visit other reactors in other parts of the country. It also organized a major national debate on nuclear energy in 1987 at Bangalore. However, the public has remained by and large sceptical and unconvinced. Every Mandal Panchayat and Zilla Parishad in North Kanara has passed formal resolutions against the proposed reactors.

Likewise, the Goa Government ought to have gone into these issues in depth. Certainly, any Government that has not done so cannot even pretend that it is a guardian of the public interest. The major issue at stake is that in the case of an accident the entire state would be effectively crippled. Just because the reactors are to be situated 20 kms from Polem is no reason to assume they are not a problem for us. On the contrary, they are a greater threat to our survival than to the people of Karnataka. Karnataka is a very large state and people can be relocated elsewhere. But this is certainly not the case with Goa. Where do the Goans go if Kaiga explodes?

This is a question to which Goan politicians have just refused to address themselves. The only Chief Minister who swore not to have any reactors in the territory because he knew they were dangerous was Dayanand Bandodkar. And he's dead. At his insistence a proposal to locate a nuclear reactor in the south of Goa in the sixties was cancelled.

The fact that the Department of Atomic Energy planned to locate reactors in Goa was confirmed when a map showing possible sites investigated for nuclear reactors was published. It showed that both Betul and Loliem had figured as possible sites. However, nothing was heard of the proposals.

No Goan politician has really protested the Kaiga project.

Both Luizinho Falheiro and Willie D'Souza, when they were with the Goa Congress, issued a press statement against the proposed Kaiga nuclear reactors. The Goa Congress was fishing for issues to raise at the time, and Kaiga came in handy. However, the moment the Goa Congress merged with the Congress (I), its concern over Kaiga evaporated. Thereafter, both Willie and Luizinho have not uttered a word about the reactors.

The M.G. party also protested the setting up of the reactors. In fact, Ramakant Khalap together with Luizinho Falheiro and J.B. Gonsalves tabled a list of starred questions in the Assembly which was answered by Dr. Luis Proto Barbosa on 11th April, 1989. One of the questions was whether the Goa Government was aware of the potential dangers to the State of Goa and its people. Another demanded to know whether the Goa Government had sent a protest to the Centre against the plant.

Barbosa's answer was to play down the similarities between the Indian and Chernobyl reactors and mouth the usual platitudes that Indian reactors were safe.

Today, Barbosa leads a government in which the MG party has a sizeable component. But the MG has made its peace with the atomic devil too. Just as Willie and Luizinho did before it. With such politicians in command, it is doubtful whether the interests of the Goan public will ever be protected.

The only party that has protested consistently against the Kaiga Atomic Plants has been the Gomant Lok Pokx. However, this party has little clout in Goan politics. To its credit, the Pokx printed and distributed leaflets against the reactors at Kaiga a couple of years ago.

Citizen action in Goa against Kaiga erupted a year ago in the form of the Stop Kaiga Movement (SKM). One of the principal organizers of the "movement" was Erasmo Sequeira, who like Khalap, Willie and Luizinho before him, was interested in exploiting the issue for political mileage: in his case, to re-enter state politics. When Erasmo was trounced in the elections, he lost interest in Kaiga too. The SKM has not made a single move after the initial signed public memorandum.

This is a pity. The SKM, while it lasted, was able to gain the support of over 100 prominent Goan men and women against the reactors at Kaiga. The setting up of the "movement" was a major shot in the arm for the people in Karwar and North Karnataka generally who were agitating against the plant.

Such a major issue should also have been taken up by the Goa University. However, except for individuals like G.R. Bhat of the Physics Department of the University, no ginger group that is seriously interested in the problem has emerged. Prof. Bhatt has written a book length study on the issue of Kaiga and nuclear power. Apart from that, the Goa Research Institute for Development (GRID) has also produced a small booklet on the Kaiga problem.

In the light of all this, it is therefore important that the SKM is revived and that it takes up the anti-nuclear issue with fresh urgency and ferociousness. Upto now, it is basically the ordinary people of North Kanara, including those in Karwar and Sirsi, who have been waging a daily battle against the proposed nuclear reactors, very often with the women in the forefront courting arrests.

Though critical equipment has been delivered to the reactor site, erection of the reactors has not yet commenced. Anti-nuclear agitators have made determined efforts to blockade the arrival of the equipment en route to the site. Thus far they have failed.

But even the commencement of construction of the nuclear reactors should not dampen spirits and lead any one to despair. The record of fully constructed nuclear reactors not being commissioned is growing. The Philippines for instance has mothballed a newly constructed reactor in Bataan. The Soviets have dumped the reactors they constructed at Krasnodor. Altogether 32 nuclear reactors in the USSR have been either stalled or mothballed. And there are many other instances from Europe and the United States of reactors being built and then kept shut due to violent popular protest.

Even at Chernobyl, the three reactors that did not explode are shortly going to be shut down for good.

Why then are we Goans waiting?

Stop Kaiga! Now!

THE KAIGA WRIT PETITION

IN THE SUPREME COURT OF INDIA
(CIVIL ORIGINAL JURISDICTION)
WRIT PETITION (CIVIL) NO.....OF 1988

A petition under Article 32 of the Constitution for enforcement of fundamental rights under Articles 14, 19 (1) (a), 21 read with 38 (1), 39 (b), 48A and 51A (g) of the Constitution of India.;

1. Dr. K. Shivaram Karanth,
   Chairman, Environmental Study and Action Committee,
   Saligram,
   South Kanara District, Karnataka.
2. Samaj Parivartana Samudaya (SPS)
   through its Coordinator,
   Shri S.R.Hiremath,
   "Ashadeep",
   Jayanagar Cross, Saptapur,
   Dharwad - 580 001 (Karnataka)
3. Shri Subramaya Ganapathy Hegde
   representing Uttar Kannada Parisara
   Samrakshana Samiti, Yellapur,
   North Kanara District,
   Karnataka.
4. Dr. Vishnu Kamath,
   456, Vivek Nagar,
   Bangalore - 560 047.
5. Shri Nagesh Narayana Hegde,
   Journalist,
   138, 5th Cross, 1st Phase,
   J.P.Nagar, Bangalore.
6. Mr. Subbaiah G. Dhogle.]
   Karnataka.] Both residents of Karwar,
7. Mr. Timmanna] North Kanara District,

--Petitioners.

VERSUS.

1. Union of India through Secretary,
   Ministry of Atomic Energy,
   South Block, New Delhi.
2. The Atomic Energy Commission through
   its Chairman,
   South Block, New Delhi - 11.
3. Nuclear Power Corporation through
   its Managing Director,
   Homi Bhaba Road,
   Colaba, Bombay.

4. Energy Regulatory Board through
its Chairman,
Homi Bhaba Road,
Colaba, Bombay.
5. Department of Environment,
Government of India,
Paryavaran Bhavan,
New Delhi.
6. State of Karnataka through its
Chief Secretary,
Vidhana Soudha,
Bangalore - 1.

--Respondents

To

The Hon'ble the Chief Justice of India and His Companion Justices of the Supreme Court of India.
The humble petition of the above named petitioners most respectfully
Showeth:

1. That this is a petition under Article 32 of the Constitution seeking inter-alia for writ of mandamus commanding the respondents to disclose and make public -

a) Report of the site selection committee set up for the purpose of deciding upon the site;
b) any environmental impact assessment, relating to the Atomic Power Plant being set up at Kaiga, Uttara Kannada District in accordance with the guidelines laid down by the Ministry of Environment and Forests;
c) documents containing studies and assessments in regard to the following:
(i) the safety and security of the nuclear power plant;
(ii) production and effluent treatment, radioactive leak-construction and operational phases;
(iii) radiation waste management and disposal;
(iv) decommissioning hazards.

2. The petitioners further seek a declaration that as citizens of India and as residents of the State of Karnataka, they have a fundamental right under Article 19(a) read with Article 14 and 39(b) to know and to be informed of all relevant details which are within the possession and custody of the respondents, in regard to the above mentioned aspects of production of nuclear energy. The petitioners further seek a declaration that any state action and in particular actions such as production of nuclear energy which has the potentiality of infringing the citizens right to life under Article 21 of the Constitution, ought to be preceded by dissemination of all relevant information which has a bearing on the effects, on the deprivation or of infringement of Fundamental Rights. Citizens have fundamental right under Article 21 to be informed and consulted about all possible aspects, which have probabilities of causing hazards to the citizens' life and permanent degradation and dimunition of the quality of environment and life sustaining elements in nature. The petitioners further seek to challenge the provisions of Sub-clauses (iii) and (iv) of Clause (c) of Section 3 and Section 18 of the Atomic Energy Act, 1962, which impose a total embargo on the publication of any information in relation to the use and operation of any nuclear power plants, as violative of Article 14, 19(1) (a) and 21 of the constitution.

Challenges to Nuclear Energy

3. "The cumulative effect of all defects and deficiencies in the design, construction, and operation of nuclear power plants makes a nuclear power plant accident, in our opinion, a certain event."

...Three Senior General Electric Engineers, February, 1976.

"The three Senior General Electric Engineers who resigned from General Electric, Nuclear Energy Division in California, U.S., submitted testimony to the Joint Committee on Atomic Energy and concluded as stated above. For the first time the public in United States had conflicting evidence from the experts, the nuclear engineers themselves. *If no plant could be guaranteed totally safe, then the nuclear industry had been making its design, construction, and operating decisions on the basis of "safe enough"*. The question of how safe is safe enough was, however, a political decision, not a technical one. From this point on, nuclear engineers, Government-agency watchdogs, and the electric utilities would increasingly be called upon to justify the social and political implications of their actions. *If engineers asserted a right to decide degrees of acceptable risk, they would be treated like politicians and not like impartial experts."*

....Peter Pringle & James Spigelman, *The Nuclear Barons*, Chapter 23.

4. In 1978 Austrians were asked in a national referendum if they wanted nuclear power. They replied to the despair and amazement of the Austrian Government which had called the referendum that they did not. The chastened Parliament then passed a law prohibiting the use of nuclear fission to produce electricity in Austria. Work on the 700 megawatt, $685 million Tullnerfeld Nuclear Power Station, just up the Danube from Vienna, was brought to a halt. Today the abandoned facility functions as a museum, where visitors come daily to contemplate the wisdom of a Government that would not (a) waste so much money on a project that has never produced a kilowatt of electricity and (b) fair enough to ask its citizens about such matters as life and death.

5. In February, 1975, 300 residents of Whyl a small village in south western Rhineland well known for its Riesling and liebraumilch wines, occupied the construction site of a 1,350 MW nuclear power station. They sat down in front of the bull-dozers and halted work. The German Police responded with water cannon and made some arrests, but the Whyl residents persisted and were later joined by others from throughout Germany and from across the border in France. With both national and international support and intense local organization, the Whyl residents were able to occupy the site for an entire year. They even built a makeshift village. Their petition against the proposed reactor attracted 90,000 signatures. In the end they won: construction was halted. The demonstration became an important precedent for future confrontations in Germany, France, and the United States, and in many there would be violent clashes and mass arrests.

6. On April 30, 1977, some two thousand Americans occupied the parking lot of a nuclear plant construction site at the quiet seaside town of Seabrook, New Hampshire. For almost ten years, the state's utility, the Public Service Company, had been planning to build twin 1,150 MW reactors on a 715 acre site near a marshy estuary that is a breeding ground for a variety of birds and marine life. It was estimated that the cooling system for the plant would use a billion gallons of sea water a day and return it to the ocean after raising its temperature by 30 degrees Fahrenheit. As elsewhere, the first protests came from local residents afraid for their jobs particularly the clam diggers and lobstermen, who feared that the warmer waters would affect the marine life. Brushing aside both these objections alongwith the fact that the site of the reactors was on a geological fault line and that the original price tag for the plant had more than doubled (to almost $2.5 billion), the Public Service Company went ahead with its plans. In 1976 it was granted a licence by the NRC. The April 1977 occupation of the Seabrook site's parking was a huge success, largely due to the hardline reaction of New Hampshire's conservative governor, Meldrim Thomson. An enthusiastic supporter of the Public Service Company's nuclear ambitions, Thomson ordered mass arrests of demonstrators, thus assuring nation wide media coverage of the event. Altogether, 1,414 people were interned. More than half of them refused to pay bail and were held for two weeks in national guard armouries, thus providing daily news stories about their welfare.

6a. On October 3, 1988 in an unprecedented show of opposition to the setting up of a nuclear power plant at Kaiga, hundreds of agitators led by the Pejawar Swamiji, Sri Vishvesha Thirtha tried to break the police cordon at the Kaiga project office in Kanwar. The agitation started around 9 A.M. and ended at 3 P.M. with the arrests of 332 satyagrahis. The agitation was a sequel to a conference, procession and public meeting held on October 2, 1988 to commemorate the birth anniversary of Mahatma Gandhi. Those arrested together with the Swamiji included his junior Sri Vishwa Prasanna Thirtha, freedom fighter H.S. Doreswamy, Mr. D.P. Kadam, a former M.P., journalist Nagesh Hegde and Dr. Kusum Sorab. The Chief Project Engineer of the Kaiga project closed the office for the day in deference to the wishes of the leaders of the agitation.

6b. On February 1, 1989, 4,000 anti-Kaiga activists were arrested including 70 women, on the second day of a three day long agitation to oppose the construction of the Kaiga atomic power plant. As many as 150 were arrested at Kaiga for holding a protest march at the Kaiga project area. They included prominent citizens of the Uttara Kannada area such as Dr. Kusum Sorab, Dr. Shant Bhat, Mr. C.D. Krishnapur, Mr. Subrahmanya Bedehakkal, Mr. Ramakrishna Dundi and others. The agitators successfully penetrated the project area from the other side of the river and stalled the project work. The agitation took a serious turn as Karwar, Sirsi, Yellapur, Honnavar and Bhatkar towns observed bandh on February 2, 1989 to protest the arrest of their leaders. Over 200 agitators staged a sit-in on the premises of the Tahsildar's office throughout the night and thousands others squatted in the area around. In Sirsi a total bandh was observed and over 200 people gheraoed the office of the Deputy Superintendent. A large number of fishermen from Belekeri, and Baitakola, Majalidala and coastal villages who came to Karwar in their boats to take part in the agitation were not allowed by the police to come ashore.

The arrested leaders refused to seek bail. The police charged the senior Sarvodaya worker Sri H.S. Doreswamy and Mr. Kadam and 218 others under sections 107, 109 and 110 of Criminal Procedure Code and presented them before the Tahsildar. The fact that Gandhians were charged under the infamous section 107 also known as chapter case caused a great deal of resentment. The Tahsildar ruled out the possibility of agitators having committed offences under Section 107. The agitators meanwhile continued the sit in and 300 others entered the Kaiga project office and staged a dharna.

Activists who had been arrested at the project area site the previous day and subsequently released started returning to Kaiga to continue the agitation. Following this the police started arresting all persons travelling towards Kaiga.

Protests continued for the sixth day in Sirsi, Yellapur, Kumta, Honnavar and Karwar to protest the location of atomic power plants at Kaiga and fishermen boycotted fishing for a whole day.

On February 10, 1989 the Urban Development Minister, R.V. Deshpande was booed and gheraoed by both party men and the public for his stance on the Kaiga nuclear power plant at various functions at Sirsi Taluka. At some places he had to mollify demonstrators by shouting Anti Kaiga slogans himself.

On February 19th, eminent literature Dr. K. Shivaram Karanth, first petitioner herein, called for the cancellation of the Kaiga project as it was in an earth quake prone area and close to both the Seabird Naval base (25 kms.) and the Supa dam (30 kms.). This is a summary of events that have occured over the last three years of the case.

7. The above are some illustration. There are many more such protests in the history of anti nuclear-weapons and energy production - protests. The petitioners herein have come to challenge the setting up of a nuclear power plant at Kaiga, in Karnataka, after sustained deliberations and considerable study of several aspects of the case. They are approaching this Hon'ble Court after failing in their efforts to make the respondents see reason in their representations and to appreciate and share the concern contained in the collective assertions. On 24.10.1986 a representation on behalf of petitioner No. 3 was submitted to the Hon'ble Prime Minister, for reconsideration of the decision to set up a nuclear power plant at Kaiga, stating inter alia as under:

"On behalf of the people of Kaiga and round about in particular, and the people of Uttara Kannada in general, the Parisara Samrakshana Samiti has been actively engaged in making people aware of atomic energy by earnestly attempting to get information regarding the benefits or hazards and alternative in the field of electricity generation. Our doubts, apprehensions and fears have not been allayed by the A.E.C. or D.A.E. inspite of our repeated requests except for a single line parrot like statement that `our technology is safe and there will be no hazard'. Convinced that they have no information to give or they do not want to give us, we are constrained to approach you with an earnest request to reconsider Kaiga".

Several representations were sent by concerned and enlightened residents of Karnataka and on 8.4.1987 the delegates who attended the conference on "Global development and energy crisis" which was held at Malaysia also sent an appeal to the Hon'ble Prime Minister to halt the Kaiga nuclear power plant.

8. Ever since human kind learnt to exploit the latent energy in uranium, man's attempts and exercises in controlling the atom have had a highly secretive zig-zag and potentially promising career. We have seen stupendous and revolutionary achievements in the realm of atomic physics. A profound contribution has been made by quantum mechanics. However the signs and technology of the various processes relating to exploitation of the awe-inspiring secrets of the atom are yet to be safe and secure. The genie has been let out of the atomic bottle. The point therefore is the social need to control the genie, and to owe responsibility to fellow citizens to share the attempts and limits of such knowledge as against operation in secrecy.

9. The pursuit of science are matters of individual innate abilities, intellect and inspiration. But once knowledge is acquired about nature and its infinite processes, such knowledge and any application of such knowledge for social purposes are matters of social concern, social responsibility and social accountability. The question therefore is not that it is only given to scientists and engineers, of the nuclear establishments to take decisions on the basis and the assumed certainties of their knowledge. The question is the need to bring within a normative framework the decision making process so as to make it democratic, socially informed and convincing. The petitionèrs are not challenging the wisdom and depth of understanding of the scientists and engineers of our nuclear establishment. The petitioners are only calling into question certain assumptions regarding certain processes during the lifetime of the nuclear power plant and the hitherto unresolved issues relating to radio active waste disposal after the lifetime of the nuclear power plant (which is on an average not more than 25 years) and the decommissioning aspect of a nuclear power plant. These assumptions are unfounded. All over the world both renowned men of science and technology and common citizens with common understanding of science and technology, have put into question many of these assumptions. It is therefore the constitutional duty and a civilised obligation of the respondents to share with the people, all its information and arrangements, relating to some of the thorny issues and challenges which have arisen, in the course of exploiting 'Atom for Peace'. ''The physicists have known sin'' said Robbert Oppenheimer after Hiroshima. He said, ''I feel have blood on our hands''. These are words of weighty moral concern and reflections of a responsible scientific mind. The petitioners only wish to state that the respondents herein, are not put in a similar predicament of echoing similar sentiments, in the event of any disastrous mishaps or even later day mistakes. The petitioners have therefore come to this Hon'ble Court, seeking its intervention, to ask for a share in pre-decisional processes, in matters of the siting of the nuclear power plant and to seek the right of the people to be consulted and to participate in all matters and in all respects of the setting up operation and decommissioning stages of a nuclear power plant. The demand of the petitioners, is consistent with Articles 14, 19(1) (a) and 21 of the constitution.

Article 39(b) obliges the state to direct its policy towards securing ''that the ownership and control of the material resources of the community are so distributed as best to subserve the common goods''. Distribution does not mean merely physical distribution, vesting all powers with regard to taking decisions on the utilisation of the material resources of the community. It means distribution subject to control for subserving the common good. The control is not mere bureaucratic or governmental control. There can be no assumption that bureaucratic or governmental control, given the lack of people's participatory processes in the existing governmental institutions, would represent the need, aspiration and consent of the people. The above said directive principles contemplates control of the material resources of the community through more direct people participating institutions. Any decision, therefore, of the respondents which runs counter to the directive principles, would be per se unreasonable and against public interest vide Kasturi Lal Reddy Vs. State of Jammu and Kashmir 1980 3 SCR 1332.

10. The petitioners seek to challenge the siting of the Kaiga Atomic Power Plant on the following aspects:

a) The unwise choice of the site, without having regard to its location in the midst of tropical evergreen and semi-evergreen forests and the location of uranium deposits.
b) That it is being located within a short radius of a cluster of ongoing hydel projects on the river Kalinadi.
c) That such a major venture is undertaken without carrying out a systematic people's participating environmental impact analysis.
d) Design faults and problems of the CANDU type reactor that has been proposed for Kaiga.
e) That it is being located near the Naval base which adds to the security risk of the entire area.

f) The total absence of any state sponsored/funded insurance for the people and their property in the event of radioactive leakages during operational phases and radioactive hazards in the event of any disasters, accidents or handling of nuclear wastes.

g) Lack of any provision for reliable waste management and disposal of spent nuclear fuel and dismantling of the reactors and the plant; and

h) The non-disclosure of real costs of nuclear power generation, including cost of waste management, decommissioning transmission losses, etc.

The ecology and environment - Losses and costs

11. It is the first time that an atomic power plant is being proposed to be erected in the middle of a tropical evergreen forest. The hill chain of Western Ghats is a rich heritage evolved through several million years. These ghats, harbour almost the entire forest wealth of the states of Gujarat, Maharashtra, Goa, Karnataka, Tamil Nadu and Kerala. The geography of these Ghats interacting with the cloud laden winds of the South West monsoon leads to the highest level of rainfall for peninsular India. Consequently almost all the major rivers of south india originate in the Western Ghats.

Over the millenia the tropical evergreen forest clothing the Ghats has evolved a tremendous genetic diversity of living organisms, a unique storehouse of many and animal species occurring nowhere else in the world. To cap it all this very chain of Ghats has a rich treasure of minerals too.

Unfortunately, this veritable treasure house of natural resources has been subjected to severe exploitation over the last few decades. A number of hydel-projects, irrigation projects, mining ventures, forest based industries, etc., have been relentlessly operated here with little regard to ecological balance or sustainability of the resource base, all to cater to a commodity oriented market economy. The Western Ghats have already paid heavily for our mistakes. This kind of mindless and one sided developmental policy has resulted in a large scale liquidation of natural resources and the gains have failed to percolate down to our masses. These hilly areas, although richly endowed with forests, minerals, and water resources are at a serious disadvantage in deriving any benefits from modern industry. The few industries that have come to this region have proven a blight rather than a boon. They have depleted natural resources, polluted the environment and brought little benefit to the local people. The fragile ecosystem has tended to collapse under the assault of exploitative development greeds. The petitioners submit that the location of an atomic power plant in this region adds a new and dangerous dimension to the ecology of the Western Ghats.

12. The Western Ghats dominate two of the three natural regions Kharavali and Malenadu and 8 of the 19 districts of Karnataka, viz. Mysore, Kodugu, Dakshina Kannada, Chickamagalur, Hassan, Shimoga, Uttara Kannada and Belgaum. They encompass all regions of rainfall higher than 1000mm - 8000mm a year in the Kudremukh Agumbe region. That is why Malaprabha, Tunga, Bhadra, Hemavathy, Kalinadi, Kaveri Kali, Sharvathy and Netravathy all have their origins in the Western Ghats. The Western Ghats is therefore a major lifeline of Karnataka and indeed the whole of south india and therefore it is essential to preserve it in its natural pristine state and halt all further developmental activities in this area. (See background paper "Save the Sadhyadris", by Madhav Gadgil which inspired the "Save the Western Ghats March" -1.11.87 to 1.2.1988.)

13. It is submitted that this petition concerns itself with the effects of erecting an atomic power station in the seismically and ecologically sensitive site at Kaiga in the Western Ghats, on human and animal health, vegetation, river systems, wild life and the unique culture of the area.

14. The proposed Kaiga Atomic Power Plant site is surrounded by a network of 5 dams, viz. Kadra, Kodsalli, Tattihalli, Dandeli and Supa dams out of a total of eleven dams proposed in the Uttara Kannada district. Of these, two dams on completion will pose a severe threat to the proposed site of the Kaiga Atomic Power Plant (KAPP).

15. The Kadra Dam of the second stage of the Kali Hydroelectric Project on completion will be just two kilometers away from the Kaiga project site. One could virtually see the riverside from the Project site. The Kalinadi river is close

by. The Supa Dam, highest of the Kali dams is situated upstream of the Kaiga Plant site. Half the dam site is on solid foundation whereas the other half lies on a faulted contact. This fault passes through close proximity of the proposed site of KAPP. The entire area falls in the Deccan Trap Basalt Zone causing additional problems. The basalts have a unique quality of undergoing drastic changes in their mechanical properties on inclusion of water within them. Moreover, of all the rocks, the basalts transmit the earthquake energy (seismic) waves most easily. The basalts are now considered to be highly unfavourable to bear any mega-hydro engineering structure. This is further testified by the fact that the reservoir induced seismicity is observed in practically all the dams constructed on Deccan type basalts, e.g., Koyna, Bhatsa, Mula, Idukki, Gandipet, etc. Incidentally, a small dam like Koyna, suffered the world's worst reservoir induced seismicity of 6.3 magnitude on the Richter scale. The Koyna earthquake of Dec. 10, 1967 killed 177 persons and 2,232 people were injured. All the houses in Koyna Nagar were damaged and 5000 left homeless. An important observation about this earthquake was that it was felt over a much larger area than one would expect earthquakes of similar magnitude to be felt in most other parts of the world. The Koyna earthquake was felt around a 700 kms. radius and it completely changed the long held image of slight seismicity of peninsular India and earth scientists became keenly interested in the investigation of seismicity and tectonics of the region. The Kaiga falls well into the region affected by this little understood fault zone.

Moreover the proposed KAPP is situated exactly in between two known seismic zones of peninsular India viz., the Panvel seismic zone and the Malabar seismic zone and is well within the Koyna earthquake zone.

16. 75% of reservoir induced seismicity of the world is known to occur within a radius of 25 kms. of the dam sites. Thus the proposed KAPP will be under constant threat of breakage after completion of the Supa Dam. Additionally dam impounding may reactivate the fault plane posing further problems for the Atomic Power Plant.

17. Finally the complex geology in the Uttara Kannada district has been considered similar to that of the Himalayan region i.e. very unstable, as a number of weak zones have been encountered. In a nutshell, the dam site is highly unsuitable for such an advanced and delicate infrastructure like an atomic power station.

18. The Kaiga site is surrounded by high hills on all sides which carry dense mixed jungles, millenia-old, with well balanced poly-cultural plants and a wildlife ecosystem. Stationing of a reactor at this site holds unknown and as yet unquantified dangers to the ecosystem as the radiation leakage through the air and water routes which are inevitable can harm the vegetation and wildlife in these natural forests.

Investigations have been performed in West-Germany by exposing an oak pine forest to a gamma ray source for six months. Ionizing radiation was indeed proved to be an environmental stress and considerable damage including death of trees close to the source was found. In the light of such observations, the KAPP must not be installed until a detailed study of the effect of radiation over an extended period of time (at least 40 years, equal to the life of the reactor) on every species of flora and fauna present in the forest is carried out.

19. Further a nuclear power plant generates a lot of heat. At the Kaiga site surrounded by steep mountains there is every likelihood of the rise in local temperature causing climatological changes and diversion of natural wind movements.

In view of all this the petitioners feel that the AEC must be prohibited from carrying out further work in Kaiga such as and inclusive of felling of trees, construction of roads and bridges, exploratory drilling and survey work till a detailed environment impact assessment is conducted accompanying the following aspects:

1) Survey and cataloging of all flora and fauna within 20 kms. radius of Kaiga.
2) Intensive study and research on the effect of radiation on all these flora and fauna.
3) Study of the effect of heat pollution on the movements of clouds and its climatic impact.
4) Study of the impact of temperature increase on biological species in the estuarine environment.
5) Study of the effect of radiation on the secondary productivity of the estuarine environment.
6) Study of the impact of noise pollution on wild life.
7) Study of the effect of electromagnetic radiation on microbial species and larger animals of the Kaiga Valley.

8) Study of the geological aspects of underground rock formations with particular emphasis on earthquake prone structures.
9) Study of the movement of underground water.
10) Study of the geochemical aspects of the mineral bearing rock formation with particular emphasis on the impact of chemical leaching on the marine flora and fauna.

20. A team of scientists not connected with the DAE comprising of geologists, geochemists, zoologists, botanists, marine biologists, climatologists, soil scientists, wildlife experts and ecologists should be assigned the task of conducting the detailed survey. It appears that the Department of Atomic Energy had carried out some environmental impact assessment. But the said study is wholly inadequate. It does not address itself to the above said aspects which are vital elements in evolving a balanced and rational perspective.

21. All life species have evolved on the planet earth in a sea of radiation consisting primarily of electromagnetic radiation in the visible range combined with a very small proportion of high energy radiation such as ultraviolet, cosmic rays and radioactivity. The latter are present in minute quantities in a highly dispersed and dilute form. The radiation that is added to the background by man's nuclear activities are in control and are harmful to the biosphere, human and animal health and also to the plants.

Health hazards -- accidents and normal operational phases

22. Every part of the nuclear fuel cycle, uranium mining, fuel fabrication and transport, atomic reactor processes and waste disposal, adds considerably to the background radiation in nature. This ''artificially'' added radiation from human activities such as the nuclear fuel cycle is of special danger to human and animal life for reasons stated above.

23. Dr. Rosalie Bertell of the Institute for Concern for Public Health has complied a handbook for estimating the health effects from exposure to ionizing radiation. The Handbook was developed as a joint project with the Institüt for Energie Und Umweltforschung (IFEU) Heidelberg, FRG in response to a request from the East German Parliament. The IFEU undertook to calculate the nuclear plant inventory of radioactive particles and the probable emissions of air, water and land for each accident scenario. They then traced the pathways through which the people living in the vicinity of the plant might be exposed to radioactive material. This information was used to calculate average radiation doses to the population. This Handbook was then used to convert doses to estimate the number of severe health effects including early deaths from nonmalignant damage to tissue, cancers, genetic and tertagenic damage, which might result from each accident. There are many other situations in which it is helpful to have a guide for ''translating'' human radiation exposure doses into probable health effects----the Handbook been expanded and adapted for these uses.

24. Radiation consists of very high energy particles emitted by unstable heavy atoms such as Uranium and others. Radiation is invisible to the naked eye and works silently and disastrously on the living organisms. Because of its ionizing nature, radiation causes damage in the living cells especially those of the nervous system, where a delicate balance of ions exists. A conclusive study performed at a site with high natural radioactivity has found a definite correlation between Down's syndrome and severe mental retardation and high background radioactivity. (See a study conducted by a team of eminent scientists of the All India Institute of Medical Science and published in NATURE 1-7-1976) Radiation also damages the chromatin structure, which is the hereditory material and these damages persist through generations manifesting themselves in cruel deformities. (See relevant chapters from Dr. John W.Gofman, *Radiation and Human Health,* Sierra Club Books, California).

25. The proposition that ''there is a threshold dose below which no damage of any kind is done to living organisms'' is a myth. It has been scientifically proved to be a mere baseless or unstudied assumption. The following is extracted from a lead editorial in `Nature' 31-7-1986: ''While much remains to be learned the biological consequences of small doses of radiation, the best assumption is that the probability of a particular kind of damage is proportional to the radiation dose, however small.'' ''And where genetic damage is in question there seems (at least for the time being) no sensible alternative to the proseposition that the risk of damage is proportional to the dose.''

26. A study of the health of workers at the Indian Rare Earths Plants at Alwaye in Kerala, carried out on behalf of the Kerala Shastra Sahitya Parishad demonstrates that at the IRE Plant the mortality rate of 80d per 10,000 workers is 3 times too high compared to a chemical factory having comparable chemical pollution and 7 times the mortality rate of workers covered under the ESI Scheme. (See V.T.Padmanabhan, *The Number Game* (KSSP, Trichur); Karl Grossman, and *Cover Up* (Permanent Press, New York).

27. *Accident and Radiation: Enough lessons*

Further, radiation offsets a wide spread effect and a single instance of radioactivity release at Chernobyl on 26 April, 1986 resulted in the spread of radioactivity over the whole of Europe. Early on 28 April, 1986, an increased level of radiation was observed at a hot cell laboratory at Studsvik located on the shore of the Baltic Sea 75 kms. south-west of Stockholm, Sweden. During the morning a message was received that increased radiation had also been observed at the Farsmark nuclear power plant 100 kms. north of Stockholm. Before noon it was observed that cars and people coming into the Studsvik site from places outside were contaminated. Sixteen different nuclides were found in proportions 4 to 15 times the normal background radiation.

Increased radioactivity was also observed in Britain where thousands of sheep which showed abnormal accumulation of radioactivity had to be destroyed. Scientific investigations on the enhanced radioactivity in Sweden and Britain after Chernobyl have been published in *Nature*.

28. There is very little knowledge of radiation. Also, there is little consensus among scientists over the estimates of cancer deaths, resulting from a single instance of radiation leakage such as Chernobyl which varies from 1,500 to over 1,00,000. Considering that there is so little knowledge, location of the atomic power plant at Kaiga exposes the local community to an unknown and unquantifiable risk and thereby depriving them of their fundamental right to life. Acting on inadequate knowledge however laudable the object may be is not responsible science. The expectation to live till one dies a natural death is itself guaranteed under Article 21. Any unreasonable interference with this expectation by state action will be unconstitutional. Action based on inadequate or prescribed knowledge will be unreasonable. This is prohibited by the Constitution under Article 14. (See a concerned report in *Science* 12-9-1986, about the conflicting claims of the experts.)

29. Estimates made by Christopher Flavin suggest that in densely populated sites such as those in India, a radioactive release of the type that happened at Chernobyl could cause more than one lakh instant deaths. (See Christopher Flavin in *Science Age*, July 1987)

30. "Nuclear power is indeed the safest, cleanest and probably the cheapest way of generating electricity". Raja Ramanna, former Chairman, Atomic Energy Commission.

These half-truths have been a part of the aggressive publicity campaign launched by the Atomic Energy Commission. The truth however is that the world's nuclear industry is plagued with accidents and there are no less than a thousand emergency shut-downs of nuclear reactors every year. The much discussed 'Three Mile Island' and 'Chernobyl' accidents are only two of a host of near catastrophies.

31. *Candu Reactors: Failure of Critical Safety Systems -- Cost-overruns and Design Failures*

The petitioners respect the expertise and eminence of concerned scientists and their zeal to advance national contribution in the realm of nuclear physics. They presume and expect that our trusted men of science would not disregard any aspect of vital concern to citizens at large. But still, the petitioners think, that it is their obligation to bring to debate, matters and facts which ought to receive their fresh concern. This Hon'ble Court would be persuaded to satisfy itself even on a cursory reading of the following materials that there is a definite need for rethinking and caution.

32. The reactor that is sought to be installed at Kaiga is the Canadian one using uranium fuel (CANADIAN DEUTERIUM URANIUM = CANDU) and heavy water as a moderator. The need for heavy water which is present in only one part in 7000 parts of water, to the extent of one tonne for every megawatt of generating capacity makes the nuclear complex difficult to maintain, and too complicated for effective functioning. Relevant extracts from a list of CANDU reactors and heavy water plants functioning in Canada as of 1982 and a review of their performance, cost and safety published by Glenden Publications, 1981, Ontario, Canada are set out below:

"Heavy water generation is a very complex and expensive process and the report states.....the heavy water plants which represent half the firm's assets will never pay for themselves."

"The actual cost of heavy water has been five times the estimated cost. All the CANDU reactors in Canada have performed below the required 80% capacity factor required to make nuclear energy viable and have operated at only 60.8%. The reactors exported from Canada have operated at only 36% capacity factor. The Canadian heavy water plants have averaged capacity factors of only 41%. The cost over-runs in construction of all CANDU reactors have exceeded the original estimates, making them twice as expensive than they were intended to be. Further every nuclear reactor operating in Canada today is operating in violation of its original license for two reasons: 1) Critical safety systems have been found to be inadequate, 2) In every reactor at least one safety system has been found to fail more frequently than the Atomic Energy Control Board (AECB), Canada permits in the license."

33. In an article in the Canadian Business Review, Spring 1982, author Gordon Edward, Chairman of the Canadian Coalition for Nuclear Responsibility (CCNR) had evaluated the probabilities that a CANDU reactor would undergo a Loss of Coolant Accident (LOCA) and the probability of a consequential core melt down in its operational lifetime of 25 years. He has also made these calculations for a nuclear industry which simultaneously operates 20 such reactors as the Indian AEC and the Atomic Energy of Canada Limited (AECL). His calculations show that a nuclear industry operating 20 reactors is certain to suffer from a Loss of Coolant Accident and the probability that the disintegration of core followed by uncontrolled release of radioactivity will take place is 7%. It is our considered opinion that these probabilities are not insignificant and the CANDU reactors are a positive public hazard and are inherently unsafe.

Presence of multiple reactors at the same site enhance the risk. Kaiga is going to have six reactors, two of which are presently being constructed. There are two reactors each at RAPP and MAPP. It deals with matters of health, environment, decommissioning wastes, insurance, accidents and other issues concerning the CANDU reactor and shows it to be expensive and dangerous.

In the light of the highly dangerous nature of the CANDU reactor it is worthwhile examining in detail the worst case accident scenario that has occured to date. viz. the Chernobyl accident. Details on the follow up action taken subsequent to the Chernobyl accident have been described in an article published in the *National Geographic*, May 1987.

34. The validity of the figures computed by Gordon Edwards and cited above can be checked for their veracity with the performance of the CANDU reactors in Canada. Canada has installed over 20 reactors and has had over twenty years experience in maintaining them. In keeping with the predictions of Gordon Edwards, Canada has already suffered a Loss of Coolant Accident at its Pickering installation. On 1 August, 1983, radioactive heavy water spewed out of a ruptured pressure tube in Pickering Unit 2 at the rate of one tonne per minute and the nuclear chain reaction continued without computer controlled automatic shut-downs being deployed. When the alarms announcing the accident went on in the nuclear plants control room, the operators despite expensive training were left largely in the dark by the CANDU's instrumentation which failed to pinpoint the exact nature and location of the accident. Unlike the U.S. style pressure vessel reactors whose critical components are available for continuous inspection, because they are available on the outside of the core, the CANDU is a pressure tube reactor the vulnerable parts of which are in the heart of the core making them impossible to inspect. (For a description of the CANDU design flaws see the *Toronto Star*, 13 August, 1983. See also researcher Norman Rubin's articles to the 'Star', (CANADA) 18 July, 1983) A series of leaks led to the closure of all Pickering units in 1983 and pleas were made by independent researchers in Canada for the shutting down of all CANDU

reactors following the Chernobyl accident. The worst case CANDU accident could cause as many as 100,000 first year fatalities and $314 billion in damages.

35. The CANDU design involves the use of heavy water as both coolant and moderator. The large inventory of heavy water in the CANDU gives rise 60 to 100 times more tritium than other reactor designs. Tritium is a very highly radioactive isotope of hydrogen, exhibiting intense activity and has a half life of 13 years. Being an isotope of hydrogen, the tritiated form as tritiated water gets easily mixed with the water system in the environment and disperses easily spreading cancer and genetic damage.

36. The CANDU model in India being a pre-1974 design is burdened with design faults of much greater magnitude involving the end-shield of the reactor. Cracks in the end-shield have forced the Atomic Energy Commission to close down the RAPP Unit I after just eight years of operations, punctuated by several hundred breakdowns and radiation exposure to thousands of workers. Thereby the RAPP Unit I is the first commercial reactor to mature for decommissioning in the whole world which is an as yet untested exercise. In 1981 prior to final closure more than 2,000 workers were exposed to severe radioactive leakage resulting in their hospitalisation. (See chapter entitled "Nuclear Power -- to have or not" in Dhirendra Sharma (ed.), *The Indian Atom*).

The high costs: established projections, and establishment versions.

37. The costs of nuclear power are exceedingly high. This has been demonstrated by David Hart to be the most expensive commercial source of electricity. David Hart has evaluated the per unit cost of electricity obtained from the Rajasthan Atomic Power plant Unit I to be 17.4 paise and the Tarapur Atomic Power plant to be 11.9 paise compared to hydel costs of 7.3 paise and coal based power station cost at 9.8 paise per unit. Atomic energy is the most expensive and unsafe way to energy self-sufficiency.

37a. A more recent costing of electricity obtained from nuclear energy and it's comparison with thermal, hydroelectric, non-conventional energy sources and decentralised sources has been carried out by Prof. A.K.N. Reddy, Chairman, Department of Industrial Management, Indian Institute of Science, Bangalore, member of the Think Tank appointed by the Government of Karnataka to advise on development policies and co-author of *Energy for Sustainable World.* This costing analysis was presented at the National Workshop on Nuclear Energy with special reference to Kaiga on 10-11 December, 1988.

The question of accountability ---- No free technology

38. The question is not one of judicial assessment or appreciation of science and technology. The question is one of judicial determination of the obligations of science and technology. The obligations are in the realm of the interaction between science and technology and nature, environment and human lives. The law of responsibility for the act of a person in regard to the effect of handling anything "likely to do-mischief if it escapes" (Rylands Vs. Fletcher 1866 IRI EX 265 onwards) is basically the evolution of a principle of accountability. With the gradual changes in the economic structure and activities of the state, varied economic functions, are being undertaken by the state either directly through the government or through its instrumentalities. In view of the enormous role which the state plays in the economic affairs of citizens, the principle of accountability needs no emphasis. In administrative law the state has been held liable to remedy a situation, or compensate a grievance, where the authorities of the state have violated statutory provisions, or contravened statutory requirements.

39. Application of science, utilisation of technological measures, are basically claimed to further the human prospect, lessen human suffering, relieve the human species from ignorance and the drudgery of burdened work, and thus add to the quality of human life. It therefore becomes a logical corollary that such attempts, are attempts which are not clouded in secrecy, or given freedom from accountability in their known and unknown effects. The petitioners' submission is that a technology cannot be judged or cleared merely with reference to its professed results or fruits. Its incompleteness or

inadequacy qua all other consequences, is an important element to adjudge not only its desirability but also the nature and degree of accountability. As of today there are no objectively acceptable and satisfactorily available process of nuclear waste disposal and reactor decommissioning. The professes solutions apart from being fanciful are basically socially irresponsible and mere exercises in justification. The justifications of the establishment are more or less repetitions of the old refrain that "we have no choice". As regards coal the difficulties are pitched to the long term problems that relate to air quality and depletion of the limited mineral sources. Environmental effects are another. With hydel power generation, equally, problems of environmental effects, rehabilitation of large populations are at least being discussed. As regards non conventional energy sources, they are asserted as not likely to play any major role in the forseeable future. There is as yet no big money or marvellous technology in them. Therefore according to the establishment, nuclear power is the only technically and economically viable solution apart from coal and hydel for bulk electricity production. This is the logic of recent thinking. Therefore instead of being honest to one's own sense of scientific and social responsibilities the attempt is to strain one's intellect to multiply justifications. The petitioners respectfully submit that there is nothing inherently marvellous about an engineering or technological feat except in its degree of adding to the quality of human life. A technology's achievement cannot be exalted to the pedestal or status of man's discovery of the infinite wonders of natural processes. The latter belong to the sphere of the sublime. The former properly relates to human utilities. The petitioners further submit that we do not know enough about radiation and can not be sure enough to permit our technological acclaim to dominated energy production and supply.

40. All that the petitioners desire to drive home is that the justification for expansion of nuclear energy programmes are value loaded judgments. They may be matters of dispute. There could be plausible points of view. But if that is so, persons in authority entrusted with state power, and acting prompted by value judgments ought to acknowledge the corresponding duties and obligations atleast when they are brought to their notice. Even this minimum requirement is unfortunately not being given adequate concern and care. Assuming that citizens' reactions are not enlightened, or not informed, or based on distortions, does not take away or minimise the societal obligations of those dealing with incomplete and inadequate technology, to concretize their con-comitant obligations and responsibilities. It is claimed that ours is an open society. But the petitioners believe that it is open only, or more for market forces and openness is at the bargaining counter with state authorities when it comes to the question of violations of people's rights and owing up responsibilities.

The unknown paths: waste disposal -- reactor decommission

41. Waste disposal and reactor decommissioning are yet unsolved and their costs are practically unquantifiable. The chief problem of nuclear technology is one of waste disposal. The waste obtained in a nuclear reactor are highly radioactive and long lived. The wastes are generated by the breaking down of the uranium nucleus (by a process called fission). This process yields a large number of unstable and highly radioactive nuclides. The half lives of the wastes, for instance, vary from 8 days for iodine 131 to 22,400 years for plutonium. There are many other wastes such as caesium 130 which has a half life of 28 years. Each of these wastes continuously emit high energy radiation and are lethal for upto ten halflives. This period varies from hundreds of years to almost eternity. For spent fuel the radioactive emission comes within an order of magnitude of natural uranium ore levels, after 10,000 years. For high level wastes it is 600-6000 years. There is no method of waste treatment that can render these radioactive wastes harmless in a shorter time frame. The concept of "effluent treatment" is non-existent in nuclear technology. (See "Nuclear wastes disposal: where and how?" in *IEEE Spectrum*, December 1980)

42. Every technology to be complete will have to have symmetric components, process component and pollution control component. The latter is to deal with treatment of waste generated during production so that the waste can be assimilated by nature without violating the environment. In case of nuclear technology there is no demonstrated method of waste treatment and the available natural environment evolved over the millenia.

43. Currently radioactive waste is disposed by storing it away in containers--steel drums, concrete hangars or geological formations, away from human habitations. Since disposal does not mitigate the dangerous qualities of the waste it is not equivalent to waste treatment and is not a medium of pollution control. Long lived radioactivity outlasts the life

of containers as well as civil engineering constructions that are used as containments. Containers have been designed to last a hundred years (as yet untested) and civil engineering constructions can last 3 to 4 hundred years, but radioactivity lasts six to ten thousand years. So as containers corrode and concrete crumbles, radioactivity will be inevitably leaked out into the biosphere and cause permanent damage. This is not merely an alarmist, futuristic prediction removed a few hundred or thousand years from now. The point is what Thomas Paine talked of ruling from the grave. There are already numerous instances where this has happened.

The case of waste dump at Hansford, Washington USA, has been described in detail in *Science*, 26.8.1987.

The burdens on the future

44. The future generations will be burdened with the task of monitoring radioactivity and maintaining nuclear installations for thousands of years. The defunct installations will have to be guarded day and night against the elements (earthquakes etc.), terrorist and enemy attacks, vandals and acts of desperation. The unknown cost of all this maintenance will have to be borne by the future generation and are problems that cannot be wished away by glib technological talk.

44a. Technical, moral and ethical issues involved in nuclear waste management have been discussed by Dr. Norman Rubin, Director of Nuclear Research, Energy Probe, Canada in his presentation entitled 'The mismanagement of Canada's Nuclear Wastes Management Program' made before the Standing Committee on Environment and Forestry, Government of Canada on 3rd February, 1987 at the Parliament Building, Ottawa. Some key passages are extracted below:

1. "The entire study of high level waste disposal is unavoidably dominated by technical uncertainties, few of which could conceivably be resolved even in decades, let alone in a few years. The technical problems briefly are as follows:

a. How to understand and predict (and model) the "expected" or "most likely" behaviour of the chemical-physical-engineering-geological system that we are planning to create underground over the course of the many thousands of years that the wastes will remain capable of doing significant biological harm to our descendants and their environment.
b. How to understand and predict (and model) the less likely but possible behaviour of the wastes disposal scheme, and how to make reasonable estimates of the likelihood (probability) of each different outcome.
c. After modelling the most likely physical-chemical-geological behaviour of the disposal option how to model (and estimate and address the enormous uncertainty in) the most likely pathways and magnitudes of biological harm, which depend on the future released and the controversial ratio between radiation exposure and health effects, but also on future population and population distribution, life style (eg. diet), new medical breakthroughs and new sensitivities etc., etc., projected very far into the future.
d. Having created a model how to assess the likelihood that it is valid i.e., thousands of years of future reality will really turn out the way the "most likely" model predicts.

2. "Until the many thousands of years have passed, there will never be a scientific way to validate any of these models, or even to be sure that any change in a model is an improvement i.e., a change towards reality, rather than a way from it.....Since the scientific community will never be able to guarantee the future integrity of a waste repository, the public as a whole must decide what to do on the basis of conflicting and uncertain "scientific" models and opinions.....since the public as a whole are the "experts" in deciding what is acceptable - in this case, what characteristics a waste disposal plan must have to be worth the risks to everybody and everybody's grand children - the public must ultimately make (or share 4) whatever decision that is made."

3. ".....the key decisions in high level nuclear waste disposal are primarily moral and ethical and only secondarily technical."

44b. The important issue here is the inability of the nuclear scientists and the industry to predict the future of nuclear waste far out into the future and whether we need to condemn children to the dirty job of living with our nuclear wastes.

45. The average lifetime of an atomic power plant is about 30 to 40 years after which the reactor will be decommissioned. There is no method for disassembly and disposal of the reactor core which will remain lethally radioactive for 6000 to 10,000 years. The core will be entombed in Sarcophagus and the Sarcophagus at Kaiga will be endangered by the sensitive dam site. The location of a power plant at Kaiga is therefore dangerous. In a matter of such grave concern it appears that the Atomic Energy Regulatory Board has not even been consulted or its prior approval taken in regard to the plant at Kaiga. The petitioners submit that even after their lifetime, nuclear plants do not retire into oblivion. They continue to tick with lethal radioactive elements. They are radiation - time bombs. The World Watch Institute has published a paper on this important aspect.

46. A nuclear reactor utilizes thousands of cusecs of water every day for its secondary cooling. The water discharged into the river after use will be very hot with temperature close to 40 degrees to 50 degrees Centigrade. This can raise the temperature of the river water to unacceptable levels for several miles downstream causing serious damage to fish and other aquatic life. In the event of any accident at Kaiga, the entire river will be polluted and the river water will disperse the radioactive waste rapidly to the downstream regions with disastrous consequences. The chemistry of water will be damaged beyond repair.

The Kaiga atomic power plant is an environmental disaster and must not be installed.

47. In view of all this, countries around the world are cutting down on their nuclear programmes. (See Christopher Flavin in *Bulletin of the Atomic Scientists*, July/August 1987.)

Energy Planning: Current models and emerging trends

48. The conventional approach to energy planning equates "development" with growth and growth with energy, which is in turn equated to centralized electricity generation plus grid transmission. Energy is therefore treated as an end in itself and the focus is on increasing energy consumption. Energy planning is then done by making projections of the energy demand into the future based on current trends, implicitly assuming that present trends will continue as usual. Such projections often forecast large gaps between demand and supply. One such projection with respect to the State of Karnataka was made for the states' Economic and Planning Council in September 1983 by a three man committee. This study computed that the deficit in power supply would start with a low of 223 MW in 1982-83 and climb to 593 MW in 1989-90. In May 1987, another committee constituted by the Government of Karnataka for preparing a "Long Range Plan for Power Projects in Karnataka 1987-2000 AD" (the SGR committee) submitted a report, which estimated the true current demand of power at 15,500 million units in 1986-87 and using a 9% overall growth rate projected a staggering demand of 47,520 million units in 1999-2000 corresponding to an installed capacity of 9,379 MW. In such a scenario, the need of an atomic power plant at Kaiga and its expansion to six units becomes imperative.

48a. However, many of the basis assumptions of the above approach to energy planning are now being questioned. This debate on energy planning has taken place in a series of articles in the national daily *Deccan Herald*. Quoted below are some of the extracts from the debate:

i. "Development should not be confused with growth in the volume of goods and services. If development is to lead to reduction of poverty, then the structure and content of growth, as well as the distribution of its benefits should be seen as being as important as the magnitude of growth. The benefits of growth do not necessarily trickle down to the poor, because its main beneficiaries invariably turn out to be the affluent. Growth therefore does not necessarily lead to development".

.....A.K.N. Reddy. The Times of India,25.12.1987.

ii. "Not withstanding its sober and rigorous approach, the three man committee's projection is riddled with assumptions. It is based on at least 16 explicit assumptions regarding the growth rates of energy consumption of different category of consumers. In addition there are a number of implicit assumptions."

These assumptions are that transmission losses cannot be reduced from the current 20%, that energy utilisation cannot improve from the current efficiencies and that no new options for energy generation will arise.

iii. "The projected demand is very sensitive to changes in some of these assumptions.....for instance if there is a weighted average reduction of about 6% in the overall energy consumption norms, the 1989-90 deficit becomes a surplus. Thus there are options other than the 470 MW of Kaiga (Phase I) for overcoming the apparent deficit.

Some of these other options have been made concrete in the recently submitted Perspective Plan for Karnataka submitted by an Expert Group appointed by the Government of Karnataka. This perspective plan showed that if five conservation measures viz.

- modernization (from an energy-efficiency point of view) of Karnataka's power intensive industries.
- incorporation of frictionless foot valves and HDPE piping in irrigation pumpsets.
- replacement of inefficient incandescent bulbs with modern compact fluorescent lamps.
- replacement of electric water heaters in homes with solar water heaters.
- use of LPG instead of electricity for cooking.

had been implemented, the 1986-87 deficit would have become a surplus of 458 MW i.e., about two Kaiga type 235 MW reactors. Thus, there are options other than Kaiga (phase I) for bridging the demand-supply gap and the argument for a nuclear power plant for Karnataka is based on a projection that ignores these other options".

iv. "The essence of the new paradigm (of energy-planning) is that energy is only a means to an end, not an end in itself. The energy system must contribute to the goals of equity, economic efficiency, environmental soundness, long term sustainability, and self-reliance. This necessarily means an emphasis not on energy consumption but on energy services, and uses and needs. The spotlight in a development focused end-end-use approach is on human beings and the services that energy provides for them, the tasks that it performs and the needs that it satisfies.....The old bias for supply increase through centralized non-renewable sources has to give way to unbiased decision between (1) efficiency improvements versus supply increases (2) decentralised versus centralized production and (3) renewable versus nonrenewable sources of energy. And the decision makers must be neutral umpires rather than partisan supporters."

....A.K.N. Reddy, *The Times of India*, 28.2.1987

48b. Karnataka has one of the most inefficient energy utilization patterns. Although Karnataka's per capita energy consumption is the lowest in the whole world, it is utilized ten to twelve times less efficiently for the production of an unit GDP compared to other developed countries. While the US uses only 1,480 tonnes of oil equivalent in energy per million dollar GDP and Japan and Italy use only 849 and 915 tonnes of oil equivalent for the same production, Karnataka utilized a staggering 8,092 tonnes of oil equivalent in energy. Increased electricity generation in the last five years has in fact increased the inefficiency of energy utilization by a further 10%. Do we need to generate more electricity?

48c. Developed countries use only 13-30% of their industrial energy as electricity, while in Karnataka 70% of the energy needs of the industries are met through electricity. Electricity being a secondary form of energy is inefficient to produce (25 unit of primary energy are required to produce one unit of electricity) and Karnataka's energy use pattern leaves much to be desired. Diversification of energy sources to primary ones will lead to massive energy conservation rendering further generation of electricity redundant. By improving efficiency of the usage of energy, with the present energy resources we can increase the per capita GDP 10 to 12 times. It is good to recall here an estimate from the study by the National Productivity Council that we can reduce our consumption very easily by 25% by incorporation of simple, inexpensive strategies in our energy use.

A further look at Karnataka's energy scene tells us that commercial energy accounts for only 50% of the total energy consumption and electrical energy consumption is less than 20% of the total. To meet the present energy requirement of Karnataka which is about 35,000 million units, renewable energy sources are more than sufficient. Actually the potential available is large compared to the requirements. These include biogas, agricultural residues, wind, mirco-hydel and others and there is need for a scientific utilization of these. Therefore future energy planning must emphasize this aspect rather

than further electricity generation which is inherently inefficient. (See Dr. D.K.Subramanian & T.V.Ramachandra, "Energy Utilization in Industries in Karnataka" in *Karnataka -- State of Environment Report* 1984-85)

48d. This realization is increasingly dawning on all the developed countries as well as in the US since 1979. More generating capacity has been ordered from small hydro plants and wind power than from coal or nuclear plants or both, not even counting the latter's cancellations. Since 1979, the US has gotten almost more than a hundred times as much new energy from savings as from all net expansions of energy supply combined and of those expansions, more new energy from sun, wind, water and wood ---- collectively now 10% of total US primary energy supply ---than from oil, gas, coal and uranium. (See Amory B Lovins, "Megawatts - Rx for Mega goofs" in *Public Power*, March-April 1986.)

What do the petitioners want from the respondents

It is evident on account of the cost factor, waste disposal and other factors that nuclear technology is not merely a technical problem but a matter of social concern, control and accountability. Even a single incident has the potential to affect the lives of a very large number of people. It is imperative that in these circumstances, that the citizens who have a fundamental right to be informed are so informed and all decisions of the Atomic Energy Commission be taken democratically after a public hearing with all the members of the local community (as has been in the Sizewell-case in United Kingdom). Section 18 (2) of the A.E.Act in fact prohibits any one from disclosing, obtaining or attempting to obtain any information about an existing or proposed plant or method of operation of such a plant and prescribes that any one contravening this prohibition may be imprisoned for a term which may extend to 5 years or with fine or with both. This is a direct violation of Articles 19 (1) (a) and 21 of the Constitution. In the absence of all relevant information the citizens will not be in a position to secure their fundamental right to life and liberty guaranteed under Article 21. The Bhopal gas leak accident is an archetypal example of what can happen when due to commercial and other extraneous reasons, information regarding the siting and process technology is not revealed to the people. The citizens' fundamental right to life cannot any more be infringed in this fashion.

50. Again information is of little use to people when they are not educated and informed enough to understand the information and utilize it in the right way for protecting their lives and liberty. The majority of the people of India have little knowledge of the issues involved in nuclear technology. They are both poor and illiterate and they should be first and foremost educated on the pros and cons of nuclear technology. The education is of utmost importance, if atomic energy is to be used "for the welfare of the people of India and for other peaceful purposes and for matters connected there with", as stated in the preamble to the act. To say that these are matters of high science and technology is to postpone accountability and openness. They remain policies of technology.

51. The Atomic Energy Commission should be subject to regulation by an independent body of technologists, scientists, private consultants and eminent citizens. Such a body should be vested with the rights of inspection, regulation and investigation of irregular incidents in the functioning of nuclear installations. The reports of this regulatory commission must be accountable and working in the interest of the public. Such independent regulatory commissions exist in most countries, and in countries like the USA, even military installations come under the purview of nuclear installations are commissioned from outside by the Nuclear Regulation Commission (NRC). Thus regulation of the working of the NRC is also a competent of nuclear regulation in the USA. In contrast, in India no independent nuclear regulatory commission exists and all regulatory powers are invested in the in-house Committee of the Atomic Energy Commission and these committees cannot work without ties. Besides the reports of these committees are not made public.

52. The Atomic Energy Commission must initiate detailed monitoring of radioactive leakage in and around all the nuclear installations in the country and make this periodic information available to the public through appropriate means. The monitoring activity must be administered by the regulatory commission and must involve members of the local community, especially teachers and students. This will be doubly beneficial acting both as regulatory as well as an educative device and help widen the consciousness of the people regarding nuclear technology. There can be no better demonstration of the peaceful application of nuclear technology than this.

53. The petitioners have not filed any similar petition earlier in this Hon'ble Court or any other High Court.

54. Being concerned as citizens in discharging fundamental duties, and aggrieved by the action of the respondents, acting in disregard of such duties, the petitioners are approaching this Hon'ble Court on the following amo[illegible] other

GROUNDS

I. That this petition raises issues which are matters of vital concern to the citizens of India. These issues have arisen for consideration for the first time and calls for judicial intervention by this Hon'ble Court.

II. That the petitioners are more concerned with the need and imperative for a fair, reasonable, just and open method of taking decisions in regard to setting up power plants for production of energy through the nuclear process. When science ceases to be mere knowledge, and technology transcends limits of utility they are subject to societal obligations and are to be held under strict subjection to pre-decisional and operational accountabilities. Assuming without admitting the need for production of energy through nuclear process, having regard to certain apparent negative features in electricity production through the thermal and hydel process, the petitioners submit that there cannot be any mechanical comparison of the benefits that may accrue and disadvantages and hazards, that may arise and be caused by the production of electricity through these different processes. Every process of production of electricity has its own unique and incomparable disadvantages and hazards. The obligation of the state, therefore, is to apply its mind and to make provisions for minimising if not eliminating the hazards, that are likely to arise even remotely and to provide for all possible compensatory measures in advance. This should be a condition precedent for taking any decision and before making any investment. The petitioners submit that so far, respondent Nos. 1 and 2 have not undertaken this exercise in respect of any of the nuclear power plants. In view of the worldwide knowledge and experience of the working of nuclear power plants over about three decades, which establishes a definite cause for concern in different areas of nuclear power generation the respondents ought to address themselves on the wisdom and necessity of providing for such of those measures, as would be fundamental and basic for minimising and eliminating the known and unknown hazards which are likely to affect people and environment. Even the National Nuclear Energy Programme published by the Lok Sabha Secretariat in the year 1985, does not address itself to this fundamental need. The action of the respondents in not discharging their duty before exercising the power is arbitrary and unfair to the citizens who expect the respondents to act with responsibility.

III. That the object of enacting the Atomic Energy Act 1962, is to provide for developing and control and use of atomic energy for the welfare of the people of India and for other peaceful purposes. Section 3 of the Act empowers the Central Government to produce, develop, use and dispose of atomic energy, as well as to provide for control over radioactive substances or radiation generating plant in order to

i) prevent radiation hazards;
ii) secure public safety and safety of persons handling radioactive substances or radiation generation plant; and
iii) ensure safe disposal of radio-active wastes;

This being the object of the power it carries with it, a corresponding duty and obligation to make provisions for the prevention of radiation hazards, securing of public safety, ensuring of safe disposal of radio-active wastes etc. The petitioners assert that the respondents Nos. 1 and 2 have not provided for these things in any known form or have disclosed them in any known manner. The only assertion made are with reference to the design and working of the nuclear power reactors. This does not carry the matter to the strict requirement of Articles 14 and 21 of the Constitution. The duty which is required to be discharged by the respondents, must find its form in a comprehensive scheme of things related to the various hazards and dangers as well as other consequences which have been demonstrated to arise and are likely to arise. Without making such a comprehensive scheme of things it is not open to the respondent to take any decision to set up and operate any nuclear power plant. The fundamental right under Article 21 has two elements. One is the right to life and liberty. The second is the aspect of the deprivation of such life and liberty. This Hon'ble Court has declared that any state action, whether by enacted law or otherwise has to be reasonable, in substance and procedure before qualifying itself for such deprivation. In the instant case the Atomic Energy Act does not contain any provisions which are reasonable within

the meaning of Article 21 of the Constitution. The action of the respondents is therefore, unconstitutional and violates Article 21 of the Constitution.

IV. That all exercise of state power is coupled with duty. The nature of the power to be exercised, will also determine the nature of duty to be discharged. There is no power of the state which does not carry with it any corresponding duty, obligation of such other compensatory action, relating to the exercise of power. In a matter like this, where the exercise of power is clouded in secrecy, it is imperative that corresponding duties and obligations are spelt out by known processes before the power is exercised. This Hon'ble Court in S.G.Jai Singhani's case 1967 (2) SCR has held:

"that the absence of arbitrary power is the first essential of the Rule of Law upon which our whole Constitutional system is based. In a system governed by Rule of Law, discretion, when conferred upon the executive authority must confine within the clearly defined limits. The Rule of Law from this point of view means that decisions should be made by the application of known principles and rules and in general such decisions should be predictable and the citizen should know where he is. If a decision is taken without any Rule which is unpredictable and such a decision is anti-thesis of a decision taken in accordance with the Rule of Law.....Where discretion is absolute, man has always suffered."

V. That the provisions of sub sections (1) and (2) of Section 18 of the Act in so far as they restrict even disclosure of information on the various aspects set out under sub sections (1) and (2) of Section 17 of the Act, are unconstitutional and violates Articles 19 (1) (a) and 21 of the Constitution. The obligations to be discharged, which have been rightly recognised under Section 17 are matters of social concern. They are not matters to be clouded in official or establishment secrecy. They call for every continuing debate and dissemination of information with people so as to ensure the discharge of the obligations, more and more perfectly and adequately. To the extent therefore, Section 18, may be read as inhibiting such disclosure it is unreasonable and violates the fundamental right to information as an integral element of speech and expression as well as the right to life and liberty under Article 21 of the Constitution.

VI. That similarly the provisions of Clause (a) of Section 3 of the Act which empowers the Central Government to have control over radio-active substance or radiation generating plant in order to prevent radiation hazards to secure public safety and ensure safe disposal of radioactive wastes, in so far as it does not impose any obligation to take specified and concrete measures which are known to the people, in order to realise this objective, is unconstitutional and violates Article 21 of the Constitution. If the power vested in the Central Government under Section 3, is integral to the entire scheme of the Act, than the power must be read to include the duty and obligation to specify, frame or enact measures in order to realise the objects mentioned under clause (2) as well as making them public in order to make them complete. If that is so, non-discharge of such duty or obligation is a very serious lapse of the respondents, which cannot be condoned.

VII. That clause (b) of Article 39 imposes on the state a duty to direct its policy towards securing that the control of the material resources of the community are so distributed as best to subserve the common good. Assuming that the Atomic Energy Act is a piece of legislation designed to serve the common good and therefore to secure control over radioactive substances, the control and exercise of power in relation to such control must be such as would not subvert the common good or ever to impair the rights and liberties of citizens. It is being increasingly demonstrated the world over that the operation of the nuclear process raises several disturbing questions, which have not been satisfactorily resolved. In the recent years we have witnessed country after country deciding to shut down its nuclear reactors. The list is increasing. The petitioners do not mean that our scientific community has therefore to sit back in despair and do nothing about it. It is indeed the excellence of human striving and the creative geniuses of the community, which add to human knowledge, and in turn to the process of liberation of the human species from its bondage of ignorance of the laws of nature. This is an ongoing process. The petitioners are not calling for a halt to this process but they only wish that responsible, and well meaning persons in authority and who have spent their life times in the process of a dialogue with nature, do exert themselves in a more responsive, concerned and objective way to the need for making provisions in regard to the various aspects enumerated in Sections 17 of the Act in particular and the fundamental right to life guaranteed under Article 21 in general.

VIII. That clause (h) of Article 51 A declares that it is the duty of every citizen of India to develop the scientific temper, humanism and the spirit of inquiry and reform. There is an urgent need for involving people in the realm of enquiry and associate people in the process of enquiry in regard to generation of power through the nuclear process. It is the obligation of the state to provide therefore for a machinery to make this participatory exercise a constitutional reality. The existing Panchayat system is one instrument which could be used. Other measures could also be conceived. If the respondents could wait and had necessarily waited to complete the nuclear power installations in the country, having regard to the dependence for technology and certain essential ingredients for the operation of nuclear reactors on certain foreign countries, it does not stand to reason that the need for enquiry in order to discharge constitutional duties could be wished away on any assumed ground of consumption of time. The right to life under Art. 21 is greater and cannot be sacrificed for the purpose of any lesser arguments.

IX. That the respondents have an obligation to draw up social security schemes including social insurance schemes, as part of the establishment and maintenance of nuclear energy production units. In the absence of such schemes, utilisation of nuclear energy production processes, and its sanction by the state, by a law or a executive design, would be unfair and unjust. This would not be procedure established by law within the meaning of Article 21 of the Constitution, as expounded by this Hon'ble Court in Maneka Gandhi's case. In fact drawing up of such social security and insurance schemes, as integral part of the Atomic Energy Act itself, ought to be a pre-requisite and condition precedent, before the nuclear energy production process could be set into motion. Such schemes, should also be made public. Unfortunately, notwithstanding the history of high risk factors in nuclear technology and the experiences of other countries which call for a wise, and socially accountable scheme of compensation, the respondents have done nothing. This is violative of Articles 14 and 21 of the International Covenant on Economic, Social and Cultural Rights of 1966, which read as follows:

"The States parties to the president covenant recognise the right of everyone to social security, including social insurance."

X. All schemes of insurance are in recognition of the obligations of the social collective to compensate losses to citizens caused by accidents -- both natural and man-made. They are in furtherance of Article 21 of the Constitution. Lack of any such statutory schemes of "nuclear processes insurance", is arbitrary and the respondents have no moral, social, and constitutional authority to go ahead with such projects.

PRAYERS

In the premises it is most respectfully prayed that this Hon'ble Court may be pleased to:

I Call for the records of the case;

II strike down subsection (i) and (ii) of Section 18 of the Act, in so far as they prohibit any disclosure of information relating to the varjous aspects mentioned in Section 17 and similarly strike down the following portion of the sub-clauses (iii) and (iv) of clause (c) of Section 3 of the Act.

III Declare that Article 19 (1) (a) read with Article 21 guaranteed to all citizens the fundamental rights to life and liberty are not jeopardised by any procedure established by law or for the purpose of enforcing statutory and other fundamental rights.

IV Interpret the word "POWER" under Section 3 to mean include `duty' in relation to the activities set down in clause (e) of Section 3 of the Act, so as to be in consonance with the Fundamental Right under Article 21 and the Statutory duty under Section 17 of the Act.

V Issue a writ of mandamus or any other writ order or direction directing

a) The respondents Nos. 1 & 2 to disclose provisions or safety schemes, if any, necessary

(i) To prevent injury being caused to health of persons likely to be employed at the premises or places and other people in the neighbourhood or otherwise either by radio-active substances in the environment;

(ii) To secure that any radio-active waste products resulting from such manufacture, production, mining treatment, storage, or use as aforesaid are disposed of safely;

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(iii) To prescribe qualifications of the persons for employment at such premises or places and the regulation of their hours of employment, minimum leave and periodical medical examination;

(iv) As regards the transport of any radioactive substance or any prescribed substance or any substance specified be an order issued under the Act as being dangerous to health to prevent injury being caused by such transport to the health of persons engaged therein and to the public at large;

b) If there are no such provisions or safety schemes as required under Section 17 of the Act, direct the respondents Nos. 1 & 2 to further make such provisions or safety schemes in regard to the above, before proceeding with the project any further;

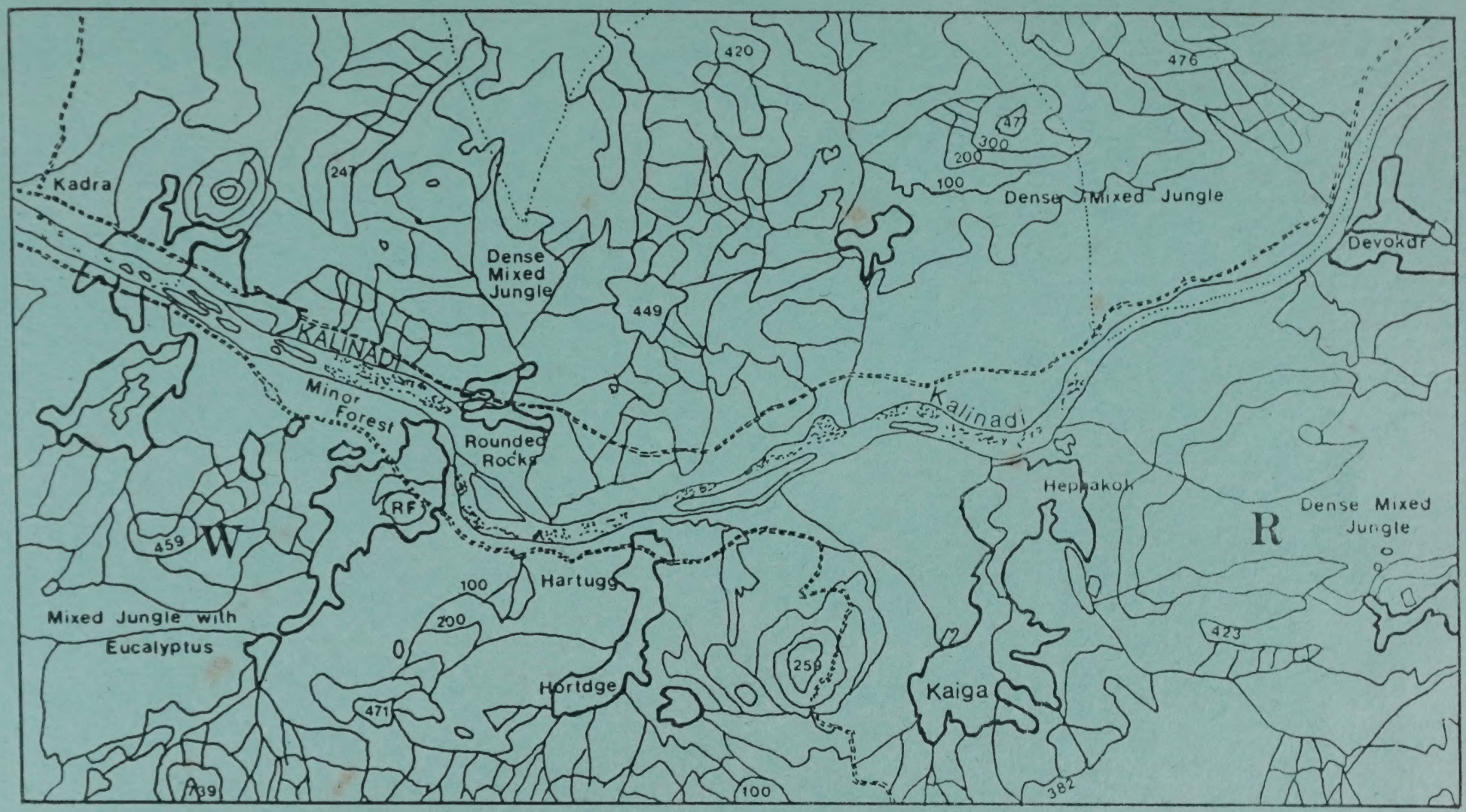
c) direct the respondents to invite suggestions and objections in respect of the Kaiga Atomic Power Plant from concerned citizens;

d) carry out a fresh environmental impact assessment on the Kaiga Atomic Power Plant with specific reference to the issues raised in the para-19 of the petition by including academicians and experts in relevant fields besides members or staff of the Atomic Energy Commission.

VI Direct the respondents to draw up social and environmental security schemes including social insurance schemes to ensure the quality of life and life of the people who are likely to be affected in any manner by any processes of nuclear energy production.

VII Direct that till the respondents comply with the above said directions, no further work on the project be undertaken, to prevent any further wasteful expenditure, and pass such further or other order(s) as this Hon'ble Court may deem fit and proper.

DRAWN AND FILED BY:
(R.VENKATARAMANI
ADVOCATE FOR THE PETITIONER
APRIL 1990 AT NEW DELHI.



AN ECOLOGICAL MAP OF KAIGA **Source**: Kaiga Petition, Vol II.

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